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PROGRESS IN AERIAL NAVIGATION.

By O. Chanute, C. E.,

President American Society of Civil Engineers.

MAN gazes at the birds and longs to imitate them. It must be confessed that his success has been small; still, within the last decade a balloon has been driven against a moderate wind, and a man is said to have flown a hundred yards near Paris, so that it may be that, as Professor Langley says, the problem of aerial navigation is about to pass into the hands of the engineers. It is an intricate and fascinating problem, and it attracted first the poets and dreamers. It is only within the last century that it has been taken up by scientific investigators, but now a number of skilled observers are investigating the elements of air resistances and reactions, and the law which governs flight, so that there has lately been a great change in the attitude of popular opinion towards the whole subject. It is no longer regarded as wholly impracticable and visionary.

Among others, Professor Pettigrew in England and Pro-

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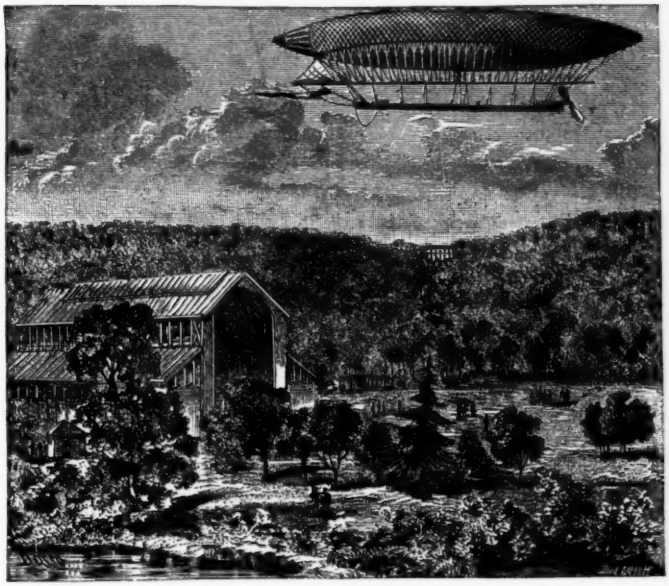
fessor Marey in France, have been studying by ingenious and accurate methods the complicated movements of birds, while in this country Professor Langley, of the Smithsonian Institution, has been experimenting upon the resistance and supporting power of planes, and has just published a report of his labors * which bids fair to mark an epoch in the development of the solution, and which he concludes with the following words :

"I wish, however, to put on record my belief that the time has come for these questions to engage the serious attention, not only of engineers, but of all interested in the possibly near practical solution of a problem, one of the most important in its consequences, of any which has ever presented itself in mechanics ; for this solution, it is here shown, cannot longer be considered beyond our capacity to reach."

Besides the men of science who are investigating the natural laws of flight and of air resistances, there are now probably some scores of sane inventors in different parts of the world, besides very many "cranks," who are making experiments in the same line of study. These men may be divided into two classes—the *Aeronauts*, who are seeking to drive balloons through the air at satisfactory speeds, and the *Aviators*, so called, who hope to imitate the birds and to fly by purely dynamical means, or without the use of the gas-bag.

As regards balloons, it has been proved that an elongated gas-bag can be propelled through the air with a screw, and steered with a rudder ; that it can be made stiff enough by internal gas pressure to resist the speeds hitherto attained, and that the velocity is limited by the power and weight of the motor, which the buoyancy of the balloon enables it to carry up. Thus far, as the outcome of various experiments dating back to 1852—first by Giffard, the inventor of the injector, next by Dupuy de Lôme, the French chief naval constructor, and then by Tissandier the distinguished author and Aeronaut—in which constantly increasing velocities had been reached—a maximum speed of fourteen miles an hour has been attained. This was accomplished by Commandant Renard of the Aeronautical establishment of the French War Department, who in 1884–85 made seven trial trips, on five of which he was enabled to return to his point of departure ; but in order to accomplish this, he had to make an air-ship—*La France*—shown in our engraving

* "Experiments in Aerodynamics," by S. P. Langley. [Smithsonian Contributions to Knowledge, No. 801.] Washington, 1891. Quarto, 115 pp.



THE WAR BALLOON "LA FRANCE" STARTING FROM SHED AT CHALAIS.

no less than 165 feet long and 27½ feet in diameter, and to build a shed to keep it sheltered, until calm weather enabled him to go out for experiment. This air-ship speed of fourteen miles per hour was obtained with an electric motor of nine horse-power, weighing with its primary battery 1174 pounds, this being the utmost that the balloon could lift in addition to its own weight and that of two Aeronauts and their supplies ; but calculations show that by simply doubling the dimensions of the air-ship, its lifting power would be so much increased that a motor weighing at the same rate—130 pounds per horse-power—would produce a speed of twenty-five miles per hour ; so that this velocity may be said to be "in sight," provided that a balloon 330 feet long does not prove to be of impracticable size.

Since 1885 no open-air experiments have been made by Commandant Renard so far as is known, but it is said that a series of experiments has been conducted to reduce the resistance of the Airship by better proportions, to increase the efficiency of the screw

and to seek for lighter motors in proportion to their energy. The latest statement is in the French periodical *Inventions Nouvelles* of October 5, 1890, that Commandant Renard is now in possession of a motor of 70 horse-power, weighing, with its supplies for ten hours, only 946 pounds, or at the rate of $13\frac{1}{2}$ pounds per horse-power. Should this prove to be true, *La France* could be driven at twenty-eight miles per hour, and an air-ship double its dimentions might theoretically attain a speed of about forty-five miles per hour, but the cargoes carried would be exceedingly small. A greater practical speed than forty miles per hour, therefore, is not to be expected from balloons, because the power required increases as the cube of the speed, and because an air-ship 330 feet long must be very near the limit of practicable sizes.

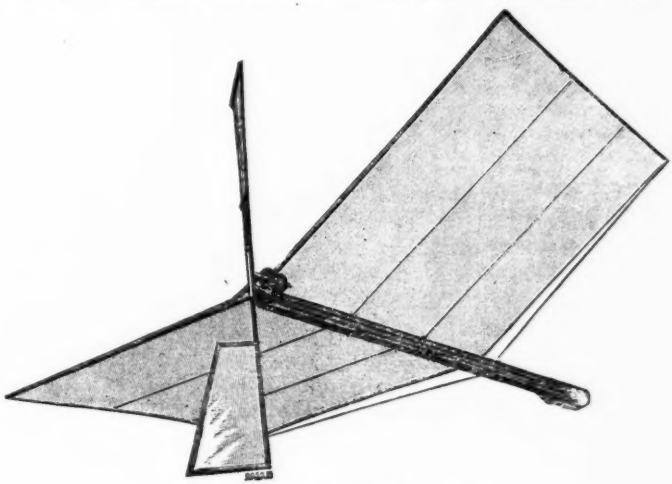
Inasmuch as the aerial problem, so far as navigable balloons are concerned, is almost wholly one of motive power, experiments on a small scale—one in which the balloon will not lift a complete primary motor—are of little or no use, while experiments on a really navigable scale are very costly. Hence such experiments are chiefly carried on at Government expense, and for war purposes. France is in the lead, but Germany, Italy, Russia and Portugal, now have war aeronautical establishments and are experimenting. It is stated that Russia is having built in Paris a "Torpedo balloon" which is to be 170 feet long, and furnished with a motor of fifty horse power, from which twenty-five miles an hour is expected. England has also an Army Aeronautical establishment which is understood to confine its labors to captive balloons for observation; but it seems to be not improbable that the other European nations are preparing aerial surprises for each other, and that should a war break out, navigable balloons would soon be seen sailing over the enemy's camps at speeds of twenty-five or more miles an hour, while all sorts of strange guns and rockets would be brought to bear upon them. But the wind sometimes blows at more than forty miles an hour, so their use will be limited and their cargoes quite small.

Hence the *Aviators* discard the balloon as too costly and slow, and point to the birds, which attain greater speeds. The pigeon flies at sixty miles per hour, the duck at ninety, and the swift is said to flash through the air at something like 150 miles an hour. The *Aviators* hope to emulate these speeds, and for the past twenty-five years, there have been aeronautical societies in Great Britain, France, Germany, and it is believed in other European

countries, which have been encouraging experiments. The machines proposed have been wondrous and many, a chart of illustrations published by M. Dieuaide in 1880, delineating no less than fifty-three machines, more than half of which had been experimented with.

It is not possible in a magazine article to review, even cursorily, all the many attempts which have been made to compass artificial flight. An account of some comparatively recent experiments will be found described in the article on "Flight" in the Encyclopædia Britannica, ninth edition. The present account will be confined to a brief sketch of the proposals and experiments of a few of the men who are still seeking a solution of the problem, and who seem to have a fair prospect of accomplishing something. First may be mentioned Mr. Breary, for twenty-five years past Secretary of the Aeronautical Society of Great Britain, who has made a great many models of flying machines, all of them actuated by the force of twisted India rubber. He has shown to the writer five or six different forms of apparatus, the principal of which is his well-known "Wave Action," all of which flew creditably in a large room, but he has never, chiefly for want of means it is said, built any machine of sufficient size to carry a man.

M. Hureau de Villeneuve, who has been nearly as long Secretary of the French Aeronautical Society, and who advocates flight

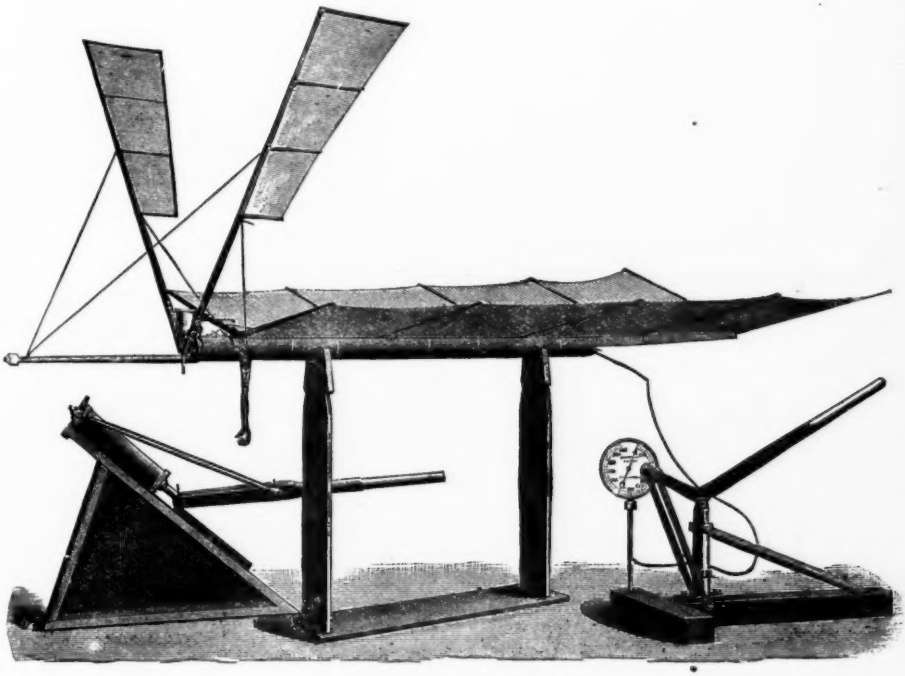


HARGRAVE'S SCREW PROPELLED AEROPLANE.

by wing action, has not only built many models which fly by the force of twisted rubber, but some years ago he constructed a large steam bird fifty feet across. As there was at that time no reliable steam-engine and boiler sufficiently light in proportion to its power, the expedient was adopted of leaving the boiler on the ground, and connecting it with the engine by a flexible hose. Upon trial, as described verbally to the writer by M. Hureau de Villeneuve, as soon as the steam was turned on, the bird, with the inventor aboard, beat his wings violently, and rose so suddenly that the alarmed inventor shut off steam and came down so rapidly that one of the wings was smashed. He has been looking since for a light steam-engine which can take up its boiler as well as the engine proper, within the limits of admissible weight, and which M. Maxim now seems to be in position to furnish.

Mr. Laurence Hargrave, of Sydney, New South Wales, has been experimenting for many years with models of flying machines, and has succeeded in getting longer flights than any hitherto obtained. Up to December 3, 1890, he had constructed nine aeroplanes, operated by bands of India-rubber, and propelled by wings ; one operated by rubber bands and a screw ; two operated by compressed air, with wings, and two operated by means of a cross bow, with wings. From Mr. Hargrave's experiments he concludes that the wing and the screw are about equally efficient in action. The engraving shows the screw-propelled aeroplane of 1888. It weighed two pounds and was driven by the contractile power of forty-eight elastic bands, geared in tension, a horizontal distance of 120 feet, by the expenditure of 196 feet pounds. Another machine in which flapping wings were similarly driven, weighed 33½ ounces, and flew a distance of 270 feet with 470 feet pounds of energy. In 1890 he constructed the compressed-air flying machine shown in the engraving. The body of the machine consists of a tube two inches in diameter and 48¼ inches long, weighing 19½ ounces, and with a capacity of 144.6 cubic inches. It holds the compressed air at a working pressure of 230 pounds to the square inch. The engine cylinder is 1½ inches diameter and 1¼ inches stroke, the total weight of the compressed air engine being 6½ ounces.

The area of the aeroplane measures 2128 square inches, and that of the wings is 216 square inches, thus giving a total area of 2344 square inches for a total weight of 2.53 pounds. The wings are made of paper, and have no feathering motion, save that due to the elasticity of the material of which they are composed.



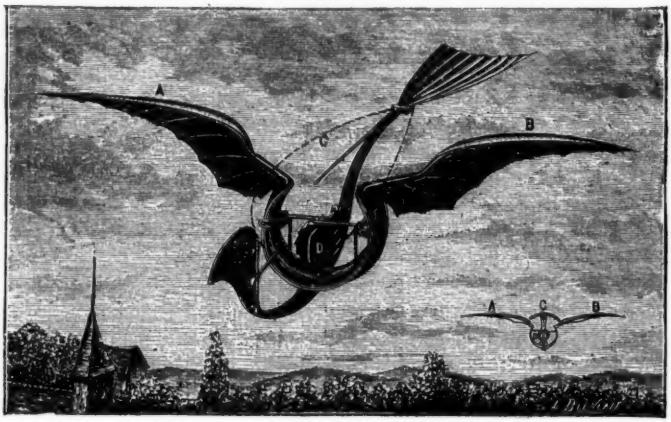
HARGRAVE'S COMPRESSED AIR FLYING MACHINE.

In a dead calm the machine flew 368 feet horizontally with an expenditure of 870 feet pounds of energy. The engraving shows also two forms of the compressing air pump. Mr. Hargrave reports the progress of his experiments regularly to the Royal Society of New South Wales, of which he is a member, and states that he desires to give the public all the information of which he is possessed, and that he does not anticipate taking out any patents.

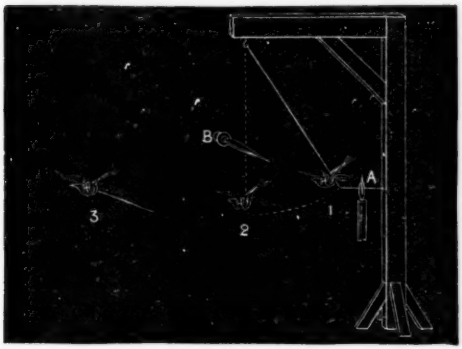
M. Gustave Trouvé, the celebrated Electrician and inventor, who had taken out up to the end of 1890, some eighty-one patents, and who is frequently referred to as "the French Edison," has constructed several working models of flying-machines. His latest mechanical bird, so far as is known, is shown in the engraving. He believes it to be the first which has risen into the air by its own unaided force, and also that its explosion motor covers the principle

which must become the primary base of all Flying Machines. The bird consists of two wings *A* and *B*, connected together through a "Bourdon" bent tube, such as is used in steam gauges, the peculiarity of which is that when pressure increases within the tube, its outer ends move apart, and return towards each other upon diminished pressure. M. Trouvé increases the efficiency of this action by putting a second tube within the first, and he produces therein a series of alternate compressions and expansions, by exploding twelve cartridges contained in the revolver barrel *D*, which communicates with the "Bourdon" tube. These explosions produce a series of strokes of the wings, which with the aid of the silk sustaining plane indicated at *C*, both support and propel the bird in the air.

The manner of starting it is represented in the diagram. The bird is suspended from a frame by a thread attached to the hammer of the revolver, thus keeping it up from the cap. Another thread holds the bird near the upright post, while a common candle *A* and a blow-pipe flame *B* complete the preparations. Upon the thread being burned at *A*, the bird swings forward from position *1* to position *2*, when the other thread being burned by the flame, the hammer falls on the cap, an explosion ensues, the tube expands and the wings strike downward, while the bird flies up as shown in position *3*. Then the gases escape from the tube, the latter re-



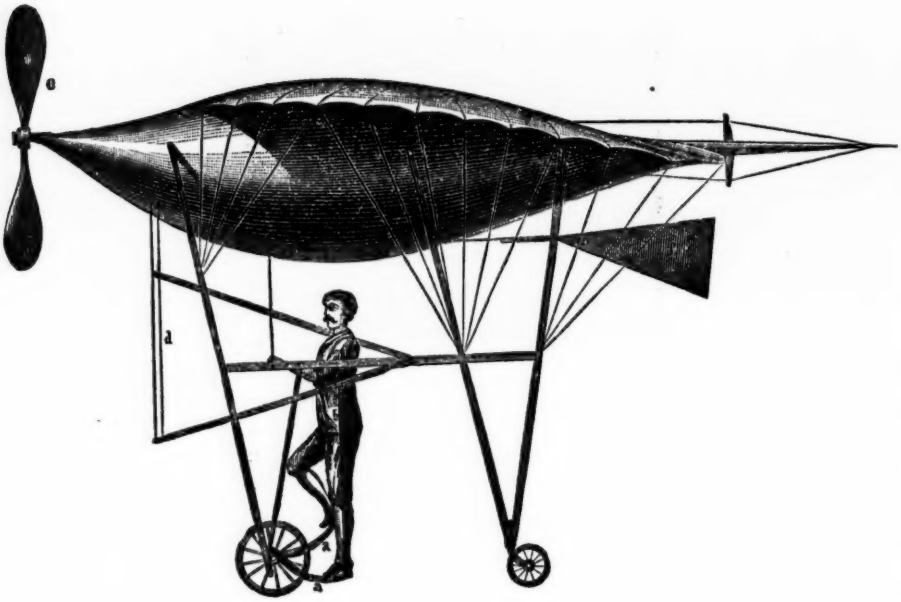
TROUVÉ'S MECHANICAL BIRD—EXPLOSION MOTOR.



METHOD OF STARTING M. TROUVÉ'S BIRD.

sumes its original shape, thus raising the wings, and also moving a pawl which advances the revolver barrel, so that a new explosion occurs, and so on. This bird has flown eighty yards, and after its motive power is exhausted, it flutters gently to the ground, the wings and silk body acting like a parachute. For practical flying machines, M. Trouvé proposes to derive most of the motive power from the atmosphere, by taking up a supply of compressed hydrogen only. This, when mixed with a due quantity of air, forms an explosive mixture which he expects to use.

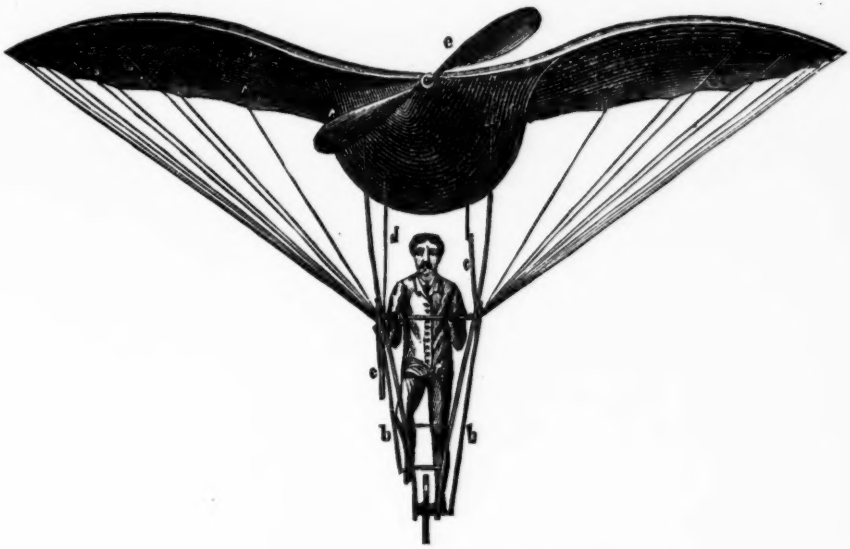
M. A. Goupil, a member of the French Aeronautical Society has given much attention to the mathematical principles of flight, and has designed a number of electrical or steam birds varying from 440 to 8800 pounds in weight. He determined first to experiment with a smaller machine, with man power, expecting to derive some support from the wind, after the manner of the soaring birds ; and in the winter of 1883, he built an aeroplane, of which a side view and a front view, as improved, are given in the engravings. It was about twenty feet across, twenty-six feet from back to rear end, measured 290 square feet in supporting area, and weighed 110 pounds. Placed in a wind varying from sixteen to twenty feet per second, at an angle of incidence of 10° it lifted up two men in addition to its own weight, making a total of 440 pounds. When the speed of the wind increased to over 20 feet per second the apparatus could no longer be mastered. The wings not being guyed fast, as shown in the engraving, they were twisted out of shape, and the wind took greater effect upon the deformed side. M.



GOUPIL'S FLYING MACHINE—SIDE VIEW.

Goupil experimented several times, and was surprised at the small amount of head resistance which the apparatus offered to the wind.

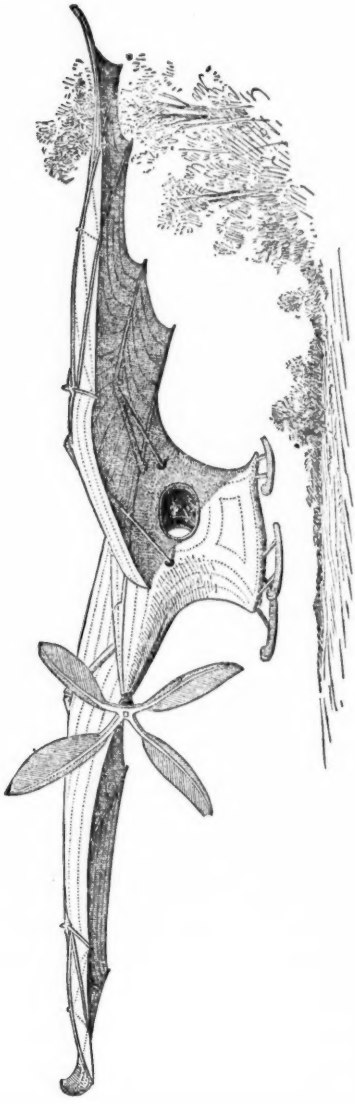
M. Ader, of Paris, a celebrated electrician, and the inventor of a telephone, for fifteen years past has been experimenting with flying machines. His later experiments have been conducted in the private park of M. Eugene Pereire, near Paris, with such secrecy as he could secure. It is now said that he succeeded last June in the presence of three or four persons, in rising to a height of about sixty feet, and in flying a distance variously estimated at 100 to 400 yards ; the discrepancy probably being due to the omitting or to the including the distance required for a preliminary run. The apparatus resembles a huge bat, fifty-four feet across, and is approximately shown in our engraving. M. Ader, upon being interviewed by the Paris newspaper, *Le Temps*, excused himself from entering into details concerning his apparatus, save to state that it



GOUPIL'S FLYING MACHINE—FRONT VIEW.

resembled a bat, that the aviator and the motor were placed inside the body of the bird, and that after trying a number of motors, he had settled upon one which employs a "combination of vapors." This actuates a screw of sail cloth placed at the head of the apparatus, thus pulling it forward instead of pushing it. The machine rests upon sled runners, or may have wheels to obtain a preliminary run, and in order to get a start, a long flat place is required, with smooth solid surface, so as to gather speed by sliding or rolling some twenty to thirty yards. M. Ader also told the reporter how for many years he had been studying the soaring birds: first the eagles and the large bats in the zoological gardens, and then the vultures at liberty, for which latter purpose he had gone to Algeria, and disguising himself as an Arab, had enticed the birds, by leaving meat for them in secluded places, so that he might observe their movements closely; the result being a new theory of flight.

It is understood that secrecy is still maintained in the experiments, M. Ader stating that he believes that his invention is destined to play an important part in the national defense, and that from



ADER'S FLYING MACHINE AS SEEN IN THE AIR.

patriotic motives he is not willing to take out foreign patents, so that he may not divulge the plans of his apparatus.

M. Mouillard, of Cairo, whose remarkable book, "L'Empire de l'air," containing a record of his keen observations of soaring birds, attracted great attention in France some ten years ago, is understood to have now, almost ready for publication, another book, which he entitles "Le Vol sans battements," in which he records further observations, and relates how he actually glided or flew some 138 feet several years ago with one of the several machines which he has invented and experimented with. This occurred in Algeria, with his apparatus No. 3, which consisted simply in a light Aeroplane strapped to the body and resting on the shoulders, but unfortunately only slightly adjustable to conform to the various conditions of flight. The wind was almost *nil*, and in order to test the carrying capacity of his Aeroplane, he took a running jump across a ten feet ditch,

when, a light breeze springing up, he was actually picked up and sailed against the wind for 138 feet, his legs dangling down within a foot of the ground, without being able to alight. Since then, he has devised several improvements to give better command of the apparatus, and he now believes that he can imitate all the evolutions of the soaring birds, and translate himself at will by the simple force of the wind. It seems now probable that several forms of this apparatus will shortly be experimented with, for the writer personally knows two American inventors, and at least three inventors abroad, who have been working on the same lines as M. Mouillard, and who believe that the wind furnishes a sufficient motive power for flight at low velocities.

When, however, high speeds are desired, power will be required, so that one of the chief obstacles to success has hitherto been the want of a motive power sufficiently light in proportion to its energy to compare favorably with that of birds. Steam-engines, gas-engines and electric motors for aerial purposes, have all weighed from 65 to 130 pounds per horse power, including supplies for only two hours, but within the last few months Mr. Hiram S. Maxim, the celebrated inventor of the "Maxim Automatic Gun," has announced that he had constructed and tested two compound steam-engines, weighing with their steam generator only 950 pounds, capable of developing 300 horse power, and already known to give 120 horse power of useful effect upon an aerial machine which he is building. Also in connection therewith an air surface condensor, forming the frame of the machine, which is expected to enable him to use the same water over and over again, thus limiting the water required for a trip to a few gallons, instead of the 20 to 25 pounds of water per horse power *per hour*, required for non-condensing engines. These marvellous achievements, should no impracticability intervene, seem destined to do more towards a solution of the problem of aerial navigation than any that have gone before, and in connection with the labors of Professor Langley and others, to promise some early results. Mr. Maxim has nearly completed in England an enormous flying machine, 110 feet across and weighing 5500 pounds, from which he expects fifty to one hundred miles per hour. These men may all fail to realize their hopes, but our understanding of the mysterious question of aerial navigation is certainly growing, and has made great advance during the past year; so that it now seems reasonably prudent for an inventor to experiment:—no longer with apprehension of being thought insane.

ONE VIEW OF THE KEELY MOTOR.

By T. Carpenter Smith, M. E.

THE Keely Motor, though discussed for many years past in the newspapers and forming the basis of more than one legal contest, has not made, so far, any apparent addition to our scientific knowledge, or marked any advance in our mechanic arts. It is entitled to serious consideration, however, because it has been successfully used to raise large sums of money, and has succeeded in holding numbers of people to absolute belief in its genuineness and faith in its unbounded possibilities. Any project which can do this so successfully, when compared with the "electric sugar-refinery" and kindred schemes, and which can raise so much apparent fresh enthusiasm over every successive test or exhibition, shows some force at work which may have great influence for good or bad on our social economy. The chief reason why this interest has been so successfully maintained is, I believe, due to the inherent attraction which any mystery possesses for mankind at large, which attraction was so tersely summed up in Barnum's famous saying: "People like to be humbugged."

Having always taken great interest in tricks of conjurors, more especially those in which mechanical means were used, and being fairly familiar with the ordinary phenomena of physics, the newspaper accounts of several of the wonderful tests did not seem to me to be very consistent, and it was with much interest, therefore, that I accepted an invitation to witness the trial of Mr. Keely's large engine, which was reported to develop 350 horse-power. Distrust does not necessarily imply suspicion, since I have had to investigate more than one case of supposed wonderful invention, and have found in some instances that the inventor was sincere, but was himself deluded, while in others the evidence of fraud was very palpable.

I need not say how diverse are the opinions held of Mr. Keely and his Motor. He has been openly accused by some of being an unmitigated fraud, while others think that he is self-deceived. Others yet again think that he has discovered a new force in nature but is himself unable to understand or control it. Among the men who have seen such an exhibition and are in this latter frame of

mind, are those whose business ability is undoubted and some whose mechanical knowledge is unquestioned ; yet these men seem to be under some influence which prevents their taking a correct view of the situation. By this I mean that they seem to overlook the fact that Mr. Keely having claimed to be able to produce effects beyond the power of the known laws of nature, the burden of proof rests with him. The phenomena he exhibits, therefore, to be of any value, should be impossible of reproduction by any means known to us. Any attempt to get from these people a detailed description of exactly what took place makes it evident that there has been some controlling agency which prevented them from examining what they saw with that unbiased and critical judgment which they would have brought to bear upon any of the ordinary business or mechanical problems of every-day life. Moreover, the slightest questioning shows that there was not any real attempt at investigation, but that the matter was rather in the nature of a formal exhibition than of a test. Our aptness as a rule to accept for truth the strong convictions of another when authoritatively expressed, simply because we have no explanation ourselves to offer, is doubtless a large factor in upholding the belief in the Keely Motor.

Now these exhibitions, as far as I know, being given always for stockholders only, there is no real opportunity for tests as usually applied ; and we find in addition that Mr. Keely's own statements as to the nature of the force vary so from time to time that it is impossible to learn anything from a comparison of one exhibition with another. Mr. Keely's original explanation of this "force" was that he produced it by the disintegration of water by means of vibrations. Shortly before I saw it his explanation was that he produced it by his discovery of the "Interatomic Ether," and the fact that there was no perceptible exhaust from the engine was given as proof of this. At the time of my visit no stress was laid on the absence of exhaust, but on the contrary the exhaust was exhibited, and a feature was made of it to demonstrate that compressed air could not be the agent employed, since in that case the room would have been "filled with snow." The "fluid" was at that time supposed to run through tubes, and we were invited to hold these tubes in our hands to show that there was no lowering of the temperature, such as would be produced, it was claimed, were compressed air passing through them. Since the test which I witnessed Mr. Keely, through his representatives, has announced that

tubes are no longer necessary to carry the force, which can now be transmitted through a solid wire; and experiments have been exhibited bearing a striking likeness to some of the simpler ones shown by Professor Thomson in his lectures on alternating currents of electricity.

Let me say frankly that in going there I did not expect to find out anything about how Mr. Keely produces the effects he shows. I acted upon the belief that his exhibitions were like the examinations which a conjuror permits his audience to make of his apparatus—namely, if there was any chance of his secret being so discovered he would not make the offer. Feeling sure that any attempt at a real examination would be at once stopped by Mr. Keely and lead to extra watchfulness, and desiring above all things to see just how much he would show when off his guard and at ease, I resolved to ask no questions, but to keep my attention solely to what he might do, and not on what he might say. A famous conjuror once placed a complicated piece of apparatus in full view of his audience, and invited them to watch it closely, defying them to find out what part it had in the trick he was about to perform. He explained afterwards that this apparatus had nothing whatever to do with the trick, but was placed there to distract attention from himself while he made the necessary manipulations. This it seemed to me might apply equally well in the case of the Keely Motor. One radical difference I at once saw between Mr. Keely's methods and those of a professional conjuror. The latter comes forward and tells you freely, "I propose to deceive you," and immediately performs some trick which compels you to admit that "seeing is not believing." On the other hand Mr. Keely offers no explanation, but expects you to believe on his simple word that he can transcend the ordinary laws of nature as known to us.

My first strong impression was in regard to the character of the audience. Most of those present were presumably stockholders, and certainly thorough believers in Mr. Keely. These, of course, came fully prepared to admire, and believe that any manifestation they saw was produced by means beyond any known mechanical principles. Among them, however, were enough men known to me both personally and by reputation as being of good business ability and mechanical knowledge to compel the thought: "If these men are believers, there must be something in Mr. Keely's claims."

It is not my intention to give any detailed account of the various pieces of apparatus. We were shown the "Generator," a com-

plicated arrangement of tubes, diaphragms and rods, and were assured that it had been all apart until a few hours before, as Mr. Keely had not expected to make a test that day. By the way, this short notice seems to be not infrequent, it being very usually given as the reason why the tests are incomplete and the apparatus unfinished.

Mr. Keely proceeded to produce the force by striking a large tuning-fork with a fiddle-bow, and then touching the Generator with the fork. After two or three attempts, which he said failed by reason of his not getting the "Chord of the mass," he turned a small valve on the top of the Generator, when a slight hiss was heard, and loud cheers greeted his announcement that he had "got it." At this moment there was evident among the strangers a strong feeling of excitement and a consequent weakening of judgment. With those who were already believers the excitement reached the point of enthusiasm. Nothing had been offered so far to prove that the power had not simply been stored up in the Generator save Mr. Keely's bare statement, yet it is doubtful if already any one of his adherents did not sincerely believe that he had personally seen the Generator in pieces when we entered the room.

The first actual demonstration of power was the raising about 2½ inches of a heavy weight on the end of a lever; this being done, it was stated, by the admission of the fluid taken from the Generator below a small piston. To accomplish this a large and a small iron cylinder were connected by tubes to the Generator and to the other apparatus. These cylinders were stated to be empty, and a small quantity of water was poured into the larger one as a measure of its internal capacity. Yet the cylinder was handled a few minutes later in a way which showed that it must have been far from as solid as this test, if correct, would indicate. The company were lost in admiration of the terrific force displayed, when, in reality, calculations showed from Mr. Keely's own figures that less than 2 horse power of actual work was needed to produce the results shown. Similarly, the company hailed the puffing of the exhaust into the room as proof that compressed air could not be the agent employed, since in that event, "the room would be filled with snow by the expansion of the air needed to produce the power displayed."

On figuring up the total amount of air that would have to be released to raise this weight, I found that 125 cubic inches of air

would be all that would be required at each stroke of this piston. No matter to what extent this had been compressed, or to what extent cooled after compression, it could not have made the slightest appreciable decrease in the temperature even of the large mass of iron surrounding it when it was released from pressure. This exhaust, by the way, was hailed by some of those present as "sweeter than a cow's breath," yet to the writer it had a distinctly oily flavor.

The most interesting part to me of the whole exhibition so far was the peculiar effect upon the majority of the audience. I saw mechanics there, who, if they had been asked to produce by ordinary means, and as a matter of mechanical design, all that we saw, could have done so immediately, and with half the hanky-panky and useless detail with which it was surrounded. Those who were competent to criticise had at first kept quiet, evidently from their unwillingness to speak without first being certain of their ground. They were now completely carried away by the enthusiasm of the others present, so that it is very doubtful if by the end of this exhibition there were more than two or three present who were not ready to declare that they had seen with their own eyes the many wonders which had in the meantime been described to them by Mr. Keely's excited admirers.

Our company was now in a fit condition to see the 350 horse-power engine. It consisted of a large copper sphere carried on a shaft which rested in bearings, and was furnished with a belt pulley and various devices called the "Regulator," or "Governor," etc. Mr. Keely apologized for the Governor not being in order, giving the same excuse of not having expected to make a test that day. Mr. Keely now produced a large iron cylinder similar to those used for holding compressed gases. This cylinder, which he called the "Receiver," had some fluid in it, which we were told was only water to cool "it" (the mysterious "fluid"). It must be remembered that to many of those present the working or not working of this machine represented the fulfillment or the blasting of the hopes of years. This produced among them a feverish tension in which common sense was at a discount, and no objection was possible to Mr. Keely's connecting this large Receiver, as well as the apparatus previously used, to the engine by means of tubes and connections. He now ordered his assistant to turn on a valve on the larger of the two cylinders previously used, and also turned the valve on the Receiver, of which he himself had particular charge, and the large

copper sphere immediately began to revolve, slowly at first, afterwards at about 150 turns a minute. The scene that followed beggared description. Hats were thrown up, cheers and yells resounded, with shouts of "Keely, you've got it!" and "Hurrah for Keely!" and the state of mind of the audience may be imagined when the shout of one enthusiast, "Keely, you are next to God Almighty!" seemed only a natural expression.

The wildest confusion reigned for some minutes, everybody turning to everybody else and exclaiming, "That settles it I guess," and other remarks of such nature. All seemed to feel that the matter was now demonstrated beyond a doubt. Mr. Keely accepted their congratulations without a particle of change of expression in his face, and in response to repeated requests stopped the machine, calling to his assistant (a man whom he called "Al"), to shut off the fluid, and simultaneously shutting the valve on the Receiver which he himself held. To reverse the machine he took hold of the Governor and pushed it in the direction in which he wished the engine to go, and then called to his man to turn the valve on the large cylinder attached to the Generator, then again turned the valve he himself held, on the Receiver. The machine would immediately start off in the opposite direction to that in which it had been running.

The various details that followed are of no material consequence, except that on placing my hand on the Receiver just at the valve outlet I found, after the engine had been run some few times, that there was a perceptible lowering of the temperature at that point. Also that while we were repeatedly assured that the Receiver had nothing to do with the motion of the engine, all the power coming from the force originally put into the large cylinder, yet "Al," misunderstanding an order, closed the valve on the large cylinder, when the machine continued to run for some little time. Mr. Keely wishing to stop, said "Shut her off, Al," and on his surprised reply, "She is shut off," Mr. Keely closed the valve at the Receiver with a suddenness that was interesting, and the machine stopped at once.

Stripped of all verbiage and mysterious surroundings, to what did this test amount? There was not one thing shown us which could not be produced by well-known mechanical means; nor was there any real inquiry. Any one who asked the simplest question tending to an honest investigation was glared at by every member of the company as though he had grossly insulted Mr. Keely and themselves.

The one feat exhibited which was interesting to me was the raising of the weighted lever, since in that case there was evidence of work done, and because it was my good fortune to hear a gentleman who had been present at a similar exhibition make the remark that if Mr. Keely wanted to demonstrate that he had a new power at his command he had the means of doing so incontestably in this single performance. His proposition broadly was:

"Mr. Keely says that this power is produced practically from nothing. Let him, therefore, take a room in any of the Safe Deposit Companies and place therein his apparatus and seal the room securely up, leaving only a means of observation. Let the room be fastened with three locks, one key to be held by Mr. Keely, one by a representative of the stockholders and one by myself, so that none of the parties interested can enter the room without the others being present. We will supply Mr. Keely with all the water that he wants, if it is water that he requires, and let him lift that weight, not once, or twice or thrice, as he shows at his exhibitions, but continuously at intervals of say fifteen seconds for only three days, and I will guarantee that he will receive all the money that he wants to perfect his invention. This money shall come, not from bankers and lawyers and business men who know nothing about mechanics, but from the first and best engineers in the country. The reason why this test would be convincing to such men is that it would really show work done. To raise in this way 500 pounds 2½ inches every fifteen seconds for three days would represent over 500 horse-power and this I believe is more actual work than has been exhibited in any manifestation that Keely has made, though far below what he claims to be able to produce at any moment. This test requires Mr. Keely to reveal nothing, and to risk revealing nothing; then why should he not accept it? He says that he does not care to satisfy the public, but only his stockholders. Then the public need waste no sympathy on his stockholders so long as they neglect this or a similar simple yet conclusive test."

THE POSSIBILITIES OF LANDSCAPE GARDENING.

By John De Wolf, L. A.

THE possibilities of landscape art in the United States are so vast, both as to æsthetic design and actual achievement, by repetition and combination of what has already been accomplished, as to satisfy the most ambitious. As a people we are beginning to appreciate the fine arts more than ever before and the art of the landscape worker will doubtless in due course receive its meed, but the truth of Lord Bacon's words—"Men shall ever see that when ages grow to civility and elegance, men come to *build stately* rather than to *garden finely*, as if gardening were the greater perfection"—is receiving new illustrations among us all the time. How often we see fine modern buildings with grounds bad in design and execution, but observing travellers note a steady improvement in this respect and there is reason in great hope for the future.

The natural resources of our beautiful country are so great and varied that little will be left ungratified in the way of landscape beauty when opportunities offer for development. Fortunately we have a land with such differences in climate and conditions that stupidity cannot reduce our grounds to a dead uniformity from the Atlantic to the Pacific, and travelling will be enjoyable for all time from the variety of scenery it gives us instead of a repetition of the same botanical display in all places. We can enjoy in their greatest perfection soft lawns and fresh foliage, where the land is bathed in the soft Atlantic air of our Eastern coast; magnificent avenues of live oaks and magnolias, further South, and those of palm trees nearest the Tropic seas. In our "New Italy," the southern part of California, are rapidly extending the charms that the gardens and villas of Rome and Naples were once alone thought to possess, and the gigantic evergreens further North exceed anything produced by Norway or Russia. Our receptive soils enable us to add the wonderful conifers of Asia and the South American mountains to the riches of Colorado and Washington. The loquat, that strange Asiatic fruit tree whose

introduction into Portugal is said to have changed the whole appearance of the country, is also naturalized in Louisiana. The moist and equable climates of China and Japan have afforded us much that succeeds wonderfully well in spite of changes that must be endured, and our hot, dry summers, so trying to many things, especially foreign methods of cultivation. While our natural resources are nearly unlimited we have much to acquire in skill and taste—especially the latter, for our methods of cultivation and the products of our gardens are in many cases far in advance of the rest of the world.

We must become preservers as well as creators. Long after the early settlement of most parts of our country the inhabitants supposed themselves surrounded with such a superabundance of sylvan beauty and charms of hill and shore, that they regarded their remorseless destruction with indifference. This trait of character is too common even now, and want of care will still cause us the loss of much that could easily be saved. Much is being done by societies and individuals to stay the destroyers, but it is difficult to accomplish good on land whose owners are indifferent or willfully aid in its spoliation. Probably preservation of nature's charms will not become general until people realize that such things have an actual money value. This was the beginning of the modern growth of the city of Newport, of Mt. Desert and of Tuxedo Park. Perhaps much was willfully destroyed at each of these places in the past but enough has been preserved for a foundation for outlay of taste and money that has rendered them famous for beauty. Hundreds of other places no less beautiful once are now neglected because the despoilers have so injured the forests or disfigured the rocks and streams that their deformities alone remain. The commercial value of these things is well understood by many a landlord who builds his great summer hotel where the charms of nature and the gardener's art do more to dispel that *ennui* so fatal to the success of a pleasure-resort than mere artificial amusements. As a rule, hotels established in picturesque localities with tastefully-kept grounds meet with success, even if difficult to reach, but without these conditions the chances are against them. Lands where the roads have been planted with shade-trees, although in the aggregate they make many thousands of miles, are difficult to purchase even now, except at extravagant prices. Those men nowadays who first clear their land of all timber large enough for firewood before offering it for sale too often still own

profitless places, while their neighbors who plant trees, clear away rubbish and assist nature, dispose of theirs at a good profit. These lessons are not altogether lost in the localities where they occur.

In view of these examples it is strange to find the common aversion to undertake anything that does not produce immediate results, so strong. Political economists tell us that as a people we gain much more than we lose by our system of government, but it is regretted that changes in ownership of land and social conditions do not favor long-continued improvements on private places. Perhaps we shall in a large measure find compensation in the grounds of those associations, which, like the Tuxedo Club and various other country clubs, aim to create fine surroundings for their club-houses and the preservation and care of beautiful natural places.

The general dissemination of true taste and some knowledge of the correct principles of landscape gardening are most important. In no better and surer way can this be done than by the object-lesson afforded by a well-designed and well-cared-for piece of ground, let the style be what it may, if only it be good of its kind. One such example has often improved a whole neighborhood. Notwithstanding the enormous fortunes many Americans acquire, our landholders as a class are people of small means who cannot afford great outlays, but must depend upon their own ability and exertions, and all the more important for this reason is it that those having the power to gratify their wishes in the way of landscape art should set a high standard of taste and correct principles of the art rather than make a lavish display of wealth. It is to be regretted that with us, public works of an æsthetic nature, requiring anything like continued care, suffer for want of that lively personal interest that cherishes many private places, and public grounds feel the evils of maladministration more readily than less changeable works. Discouraging and disheartening as many attempts have been, and if far behind what they should often be, the results in most places are such as to give us hope for the future. The positive and delightful attractions in the parks of New York, Brooklyn, Philadelphia, Washington and many of our Western cities, in spite of adverse conditions, should inspire other places with encouragement.

Now that we are coming to believe there are things already with us having attractions and in many cases qualities better adapted for our own people than foreign trees and arts, we are on the way

to true improvement. The want of appreciation of our native things so long prevalent is one of the most curious phases to those who study the art of landscape gardening in America. During the earlier progress of the country the adaptation of foreign methods and the frequent use of native plants was most successfully practised, but later this seems to have given way to senseless imitation of foreign things. Many of our most desirable native trees and plants had to be carried aboad and there seen and admired by travellers from America and brought back again before they were admitted to our ornamental grounds. True patriotism would seem to teach us to improve and beautify our land by the best, from whatever source obtained. We must adapt that which is good in the designs and practices of foreigners but cease imitation of foreign things alien to our institutions and uncongenial to our land.

Not many years ago few Americans thought of employing an architect except in the erection of some building of more than ordinary pretensions, for public use or business, but now hardly a cottage is planned without professional aid. The decided improvements in domestic architecture now seen are due more to this employment of trained skill than all else. It is true that we see many ridiculous and unfit structures, but these more often occur for want of professional skill than by bad advice from an architect. As the success of all architectural creations is so largely due to proper adaptation of means to the desired end and skillful study of the ground, people will soon as surely employ a landscape architect to carry out their wishes as they now do an architect for the erection of their buildings. Like all true artists the genuine landscape worker suffers from want of appreciation, and is peculiarly liable to it, for often the growth of years is required to bring his work to perfection, and the place is then admired by all while its departed author is forgotten. Perhaps just as trying are those people who admire and want all that is showy, no matter how bad. Their perverted taste encourages the rise of empirics whose only object is to give present satisfaction and get their pay. They are in a great measure responsible for the excessive use of tender plants that perish after one summer, and have been so much in fashion for some time past and have discouraged many people from attempting gardening, from the annual expense and great attention required to attain anything like success in what they were told was the only style worth having. Nothing is more popular among vis-

itors to our parks, especially in Chicago and at some of the larger watering places on the coast. In proximity to statues, as in the Boston public garden, and buildings where all the surroundings are purely artificial, it does not seem out of place and furnishes a brilliancy for a short time that can hardly be obtained by other methods. If it leads to better things it is not to be regretted. We are improving, however, for the sale of more permanent trees, shrubs and hardy perennials is steadily increasing.

Much landscape gardening has been called for in places so poor in soil and with such a lack of all picturesqueness of surroundings that the results suffer in comparison with work in more favored localities and the designer is often unjustly criticised. Proximity to large cities is often the reason for creation of work of this sort and the raw and forbidding appearance of the site is what inspired their first inception. Wonderful as many of these places are and illustrative of the triumph of horticultural art over obstacles, they are far from satisfactory when compared with places more fortunate in situation and conditions. A landscape gardener is rarely allowed to choose his own working ground, but must improve the place that is given him. The results in some instances are so inadequate to the cost, in the opinion of many people, as to discredit an art capable of more beautiful forms of expression than any other, but with decided limitations.

For those who are true philanthrophists there is no way more sure to improve and benefit their fellow-men, rich and poor, than by giving them appropriate pleasure-grounds. They are never out of place and never without a refining influence whether in the midst of a crowded city, in the suburbs, or among rural scenes. Vandals will destroy, it is true, and where will they not? But the damage they do is wonderfully little compared to the opportunity offered, no other public property being so much respected. They foster public spirit and love of country, cultivate the taste and improve the health of all within the range of their influence, and no one as yet knows anything of evil against them. Whether purely artificial on the sands of the sea-shore, as the Golden Gate Park in San Francisco, or the preservation of the wonders and beauty of nature, as at Lake Mohonk, they inspire us with emotions of pleasure. No form of memorial seems more fitting to those who have rendered great service to their country than the dedication of a portion of the land they loved so well to their memory, and the scenes of illustrious deeds always interest us more than an ordinary

piece of ground, making often the most fitting site for a park. These things must be treated as works of art, however, or they will throw ridicule on the memory of those whom they are intended to commemorate.

The growing sentiment in favor of good roads and their practical improvement in so many places is one of the most encouraging signs of the times. No part of landscape gardening is more important than this, for on their perfection depends the enjoyment of all else. When their projectors have finished their improvements in this way they are likely to turn their attention to other things, and the field is unlimited. It is strange that many people do not realize the intimate connection between work in engineering that is purely practical in character and that which is beautiful. This feeling may have been enhanced in the past by the attitude of some engineers whose perceptions of beauty were unusually dull and who affected to despise everything they did not consider practical. There is no more reason why a work of utility should not be handsome in the highest sense than that all engineers should be ugly men. We can haul heavy loads over smooth, well-built, beautiful and shaded roads just as well as if we deprive them of all beautiful features and make the work unpleasant. The bugbear of great cost has done much to spread ugliness abroad, but a beautiful design is not necessarily more expensive to carry out than an ugly one. The engineer and the landscape gardener, if they are not one, should work together from the beginning. To employ first one and then the other is like getting a coat made by one tailor and then taking it to another to be fitted to the wearer When harmony of work goes on, fitness and utility will result and give the highest beauty and satisfaction. The highest utility is often the highest beauty.

Great results have followed from the owners of adjoining property uniting in a common plan of improvement, and thus transforming whole neighborhoods. "The first province of landscape gardening is the removal of nuisances," and the change that occurs in the removal of useless fences, diseased and crowding trees, barnyards and pig-sties on the road, is little short of marvellous. In the way of construction and ornamentation the best results are usually obtained from materials found near at hand. The most costly and magnificent bronze and stone are not out of keeping in certain situations and in works of magnitude and grandeur, but for ordinary purposes the judicious use of the rocks and gravel, sand and

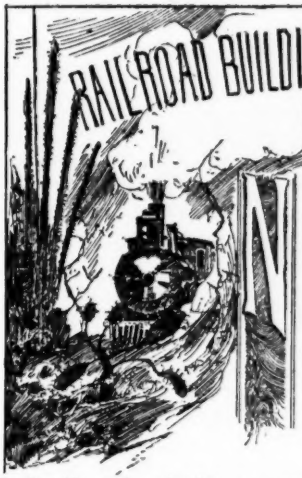
earth where they abound will be found more fitting. Observation and attention to the work of others is of the greatest assistance, but each situation, with the exception of a perfect flat, requires special study and treatment to develop its utmost capabilities. We are a nation of travellers, and many among us must see all there is in our own and in foreign countries, and with a discriminating taste we should not only excel others, but put the world ahead in true art and happiness. Even our railroads are beginning to feel the effects of the new order of things, and some praiseworthy efforts are being made to redeem their ugliness. Let us hope that in future they will not carry desolation and destruction alone, wherever they are laid down through the country, robbing it of natural loveliness, but be an example to all travellers of the highest fitness, the perfect union of utility and beauty, one and the same. These ideas are not Utopian, for enough has already been done about some of the stations and tracks of railroads in New Jersey and Massachusetts to mollify even the animosity of Ruskin and show it to be within the easy possibilities of the future that these great highways shall carry culture and art wherever their engines are heard, while bringing dollars to the bank-account of our millionaires.

Our waterways are also receiving more fitting attention and adding to the pleasures of travel by landscape treatment, and the modern lily-ponds and water-gardens are a true advance over what older nations knew.

When as a people we become familiar with the best that has been done with ground and trees and water, and our taste is equal to our zeal, we can accomplish things that men have not yet seen the equal of, and with the wealth of material now available can excel in our trying but exuberant climates all the earth has had to boast of. While in horticultural specimens and the production of gorgeous flowers we now lead the world, we must yet become imbued with the broad principles of the art of landscape gardening, practice them in conjunction with our neighbors, cease devoting much time and energy to petty work and temporary details, to attain the highest possibilities, and then will our people live surrounded by parks and gardens, from ocean to ocean.

We must build upon broad foundations and in a way that time will improve, not perish, our work. Plant long-lived trees so that they will thrive and develop rather than crowd and kill each other. Make our roads and bridges good and truly beautiful, even if they are rough and rustic. Give nature a chance, but subdue

her wildness. Let us build country-houses amid rural surroundings, whether they are of onyx and marbles, or of wooden slabs with straw roofs, and cease the erection of great structures of inconvenience now common among us. Imitations of foreign things may flourish for a time, but cannot take root and become naturalized. By harmony of action in municipal, country, state and individual enterprise, we must reach a development, true, beautiful, original and American, before we can be in the van of Landscape Gardening as in the other fine arts.

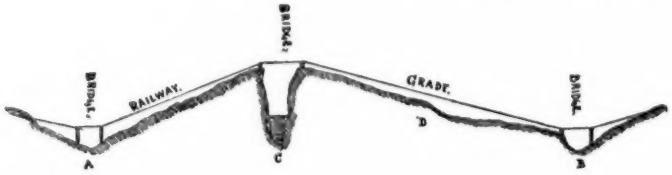


NO part of the United States has attracted more attention than Texas, and the recent extension of railway facilities in that State, with the consequent increase in wealth and population which has resulted, may be ranked among the remarkable achievements of the latter half of the nineteenth century. With an area of over 260,000 square miles Texas is an empire in itself, and only by comparison can one realize how large the State really is. For instance, the Southern Pacific Railway traverses from El Paso to Orange, a distance of something like 950 miles, while the main line of the Texas and Pacific from the Louisiana line to El Paso is 810 miles nearly directly east and west across the State.

In March, 1880, the writer joined the engineering corps of the Pacific Railway Improvement Company, which was organized to complete the Texas and Pacific Railway from Fort Worth to El Paso, a distance of 612 miles. At that time track-laying on the road had been suspended for two years, and it was considered necessary in order to secure the land grants that the main line be constructed and put into operation to El Paso on or before January 1, 1882. The task set for the engineers was to complete 612 miles of railway in twenty-two months, with nearly 400 miles of it through a region entirely destitute of population, the cattlemen at that time having failed even to penetrate the greater portion with their herds.

At Fort Worth the elevation above tide-water is 629 feet with the country rising to the west and northwest; the summit of the Staked Plains being 3300 feet, Carrizo pass 4500, and El Paso 3800 feet. Topographically the region ascends by a series of well-defined terraces. The differences in elevation cause such modification of climate as to make a trip across Texas a series of surprises. At Marshall in the eastern part we find a heavily-timbered

region with high humidity and rainfall of probably 35 to 45 inches per annum. At Fort Worth the timber has disappeared except along the streams, and the rainfall and humidity are much lower. Going west the rainfall and humidity both further decrease until on the Staked Plains there is an average rainfall of 20 inches, and an atmosphere with less than fifty per cent. of humidity during most of the year. At El Paso the rainfall is about 13 inches per year, occasionally falling as low as 5 inches. The whole region is nevertheless subject to great variation and irregularity in the distribution of rainfall. In October, 1881, after an interval of almost no rain for two years, eight inches fell in twenty-four hours in the region west of the Pecos River. During this rain I was at Toyah, a division point on the Texas and Pacific twenty miles west of the Pecos. The soil thereabouts is chiefly of heavy clay, absorbing water slowly, and at the end of the storm the whole country was literally afloat. For a number of miles the



slope is uniform and without clearly defined water-courses, and torrents of water came pouring down this slope as though a large river had been suddenly spread over the high country to the northwest. These heavy rainfalls are characteristic of the whole region along the line of the Texas and Pacific, and presumably over a large portion of the State, and the determination of the size of the waterway to be left at the various streams is the most vexatious problem with which the engineer has to deal.

Many of the streams carry considerable silt, and by overflow year after year, and deposit of the silt at the sides, have gradually raised themselves above the surrounding country, becoming what are technically known as irrigating streams. The area of channel of the stream itself is frequently only a small portion of that required to take care of the flood flow in the low points at the sides. A good example of such a stream is afforded by the Clear Fork of the Brazos River, the bridge over which is on a summit something like twenty feet higher than the grade one-half mile east and thirty

feet higher than the grade one and one-half miles west. This condition of affairs is illustrated by the preceding sketch.

To the north of the line opposite D, are a number of small ponds, and in their vicinity engineers and contractors pitched their camps in the fall of 1880. A few old plainsmen who passed while this part of the line was building averred that the ground occupied by the camps had been a few years previously from ten to fifteen feet under water, but in the absence of any visible evidence of such flood this statement was considered somewhat apocryphal. The railway was located and constructed as shown in the sketch with openings at A, B and C, those at A and B being relatively much smaller than that at C. Three years later the old plainsmen's story was corroborated. A storm occurred of such violence as to flood the whole valley and nearly obliterate the railway embankment from A to B. Those who occupied the camps opposite D, in 1880, had reason to thank their lucky stars that such excessive rainfall held off until they had gone to safer localities.

The elevated plains destitute of water on the surface and with an atmosphere of exceedingly low humidity, present new conditions of life in every direction. In the hot days of midsummer, men laboring at grading and track-laying used an average of between three and four gallons of water each day. The absence of water on the surface rendered the problem of water supply during construction a difficult one, and in many places the only way was to haul long distances by wagon. After the track was laid, water was hauled by train, in some cases more than one hundred and fifty miles. Getting out of water on a hot July or August day was a serious matter. In July, 1880, a party started from Mustang Springs near the eastern edge of the Staked Plains, to run a distance of about seventy miles, to the Sand Hills, where it was expected a pond could be easily found. Unfortunately the time required was longer than had been anticipated and when the party arrived there the stock of water was exhausted, the party had been on short rations for two days, and all were suffering from thirst. A search for the pond failed to reveal its whereabouts and a stampede ensued. Mules, wagons and accoutrements were abandoned and the party started every man for himself, for the Pecos River, thirty miles away. The intervening country was alkali desert with little vegetation save a stunted growth of sage bush. All lived to reach the river, though several sank exhausted when a short distance from it, and were only revived by their more fortunate companions returning to

them with water. A number subsequently died from the effects of the exposure. After several weeks, the survivors returned to the abandoned outfit and discovered that the mules had found their way to the pond for which the party had been searching and had become fat feeding upon the excellent grass growing on the margin. The pond itself was only three miles from the point where the stampede occurred.

Many of these waters are strongly alkaline and their use for either man, beast or locomotive cannot be recommended. The Pecos River carries so much silt in suspension that a pailful after standing for an hour has a deposit of mud at the bottom nearly three inches deep ; and a large camp out of water and waiting impatiently the arrival of wagons loaded with such supplies as this, presents a picture of discomfort which one must experience in order to fully appreciate.

The building of 612 miles of railway in twenty-two months would require the completion of about nine-tenths of a mile of main line for every day, as an average. Taking the actual rate of track-laying as measuring the progress of the work, the showing is as follows: The first one hundred miles was laid in 190 days, the second in 159 days, the third in 102 days, and the fourth in 67 days ; while the balance of the distance, one hundred and twenty miles to Sierra Blanca, where the work was finally terminated by junction with the Southern Pacific, was laid in 97 days, and a considerable portion of this as well as the fourth hundred was at the rate of two miles for every working day. Somewhat better average results have been obtained on other work, but for rapid track-laying under all sorts of disadvantages, this record of the Texas and Pacific extension stands unique. The rate of two miles for every working day was maintained for several months during which time the amount of material brought to the front exceeded one hundred cars daily. Ties, fuel and bridge timber were transported from East Texas, a distance of from four to six hundred miles ; rails from Pennsylvania, fifteen to seventeen hundred miles, and water from wherever it could be got along the line.

As the work proceeded the water supply question became more and more pressing, and it was concluded to make some systematic effort to develop the possibilities of an adequate supply. The writer was furnished with an outfit of boring appliances and placed in charge of this work in August, 1881. The net result was the definite determination that from the east side of the Staked Plains to

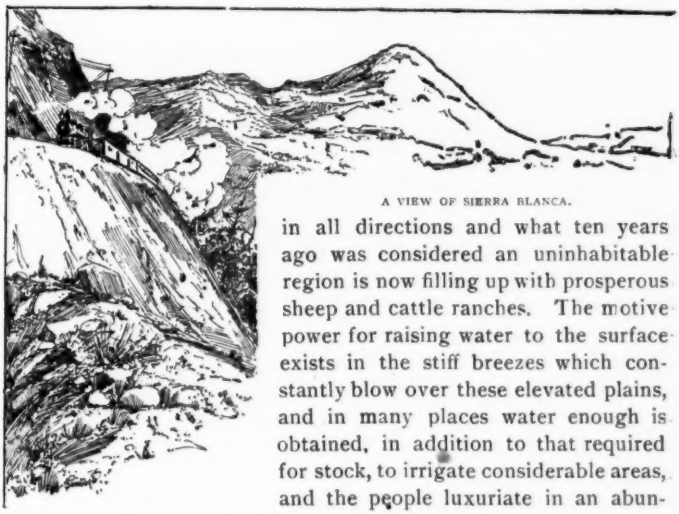
ON THE SOUTHERN PACIFIC NEAR DEL RIO.

the Pecos River ample supplies of water could be got without exceeding seventy feet in depth; while from the Pecos River to El Paso, the depth at which water was found varied from 250 feet at Toyah to 560 feet at Van Horn.

The well at Toyah deserves special mention. It was originally bored to a depth of about 250 feet, and a flow of strong black sulphur water rose to within forty feet of the surface. Such study of the geology as could be made seemed to indicate that the sandstones of the Gomez mountain dipped under this locality and there was a fair prospect that deeper boring would be rewarded by water of good quality, and perhaps a flowing well might be obtained. The original well was accordingly reamed, larger casing inserted shutting out the sulphur water, and the boring was driven to a depth of about 900 feet, where a second vein of sulphur water stronger even than the first was encountered. This rose to the surface and flowed a vigorous stream, but the quality was too discouraging to justify further boring.

Monahan's well at the west edge of the Sand Hills also deserves mention as one of the famous watering-places of West Texas. The original well was dug by a contractor named Monahan who had ten miles of work in the sand and alkali wastes with apparently no water attainable except from a pond several miles distant. The hauling of heavy loads of water through the light sand was so great a labor that Monahan concluded to try sinking a well. This was in April, 1881, and in advance of any borings in that vicinity. The point selected was in the midst of a dreary waste of white sand nearly destitute of vegetation, and as unpromising a place as could well be imagined. Monahan excavated fifty feet through sand with no other appliances than pick and shovel and windlass, and no promise of reward, but at that depth found an abundant flow of soft water in a stratum of white sand seven feet thick with impervious hard-pan beneath. In September following a large well was sunk at this point and a flow obtained of from forty to fifty thousand gallons in twenty-four hours.

The value of the discovery to this region was beyond estimate. The Sand Hills and alkali plains are nearly barren and larger supplies than can be obtained from wells by the use of windmills are necessary to wholly reclaim them. The Staked Plains, however, yield nutritious grasses in abundance, and the development of a water supply beneath the surface was all that was needed to make them the seat of large grazing interests. Since these first borings, wells have been put down

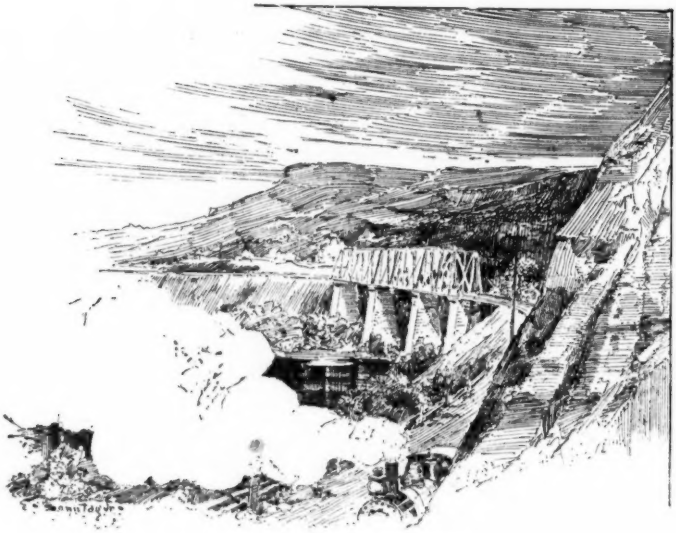


A VIEW OF SIERRA BLANCA.

in all directions and what ten years ago was considered an uninhabitable region is now filling up with prosperous sheep and cattle ranches. The motive power for raising water to the surface exists in the stiff breezes which constantly blow over these elevated plains, and in many places water enough is obtained, in addition to that required for stock, to irrigate considerable areas, and the people luxuriate in an abundant semi-tropical vegetation about their homes.

The valley of the Rio Grande east of El Paso, the Quitman and Blanco cañons, and the mesa flanked by the Carrizo and Eagle mountains presented during the summer and fall of 1881 a scene of activity certainly never before witnessed in West Texas. The Southern Pacific and the Texas and Pacific Railways were building nearly side by side for a distance of one hundred miles, where only twelve months before the Apache had roamed in undisturbed possession. What the Indian thought of this will never be known, but there is evidence that he occasionally crossed over the Rio Grande from his fastnesses in Northern Mexico, ascended the Eagle Mountains and looked down upon the conquest of his favorite range. In January, 1882, I climbed the highest peak of the Eagle Mountains and found at the summit an abandoned camp, with tepee still standing, and cooking uten-

SIGNAL MOUNTAIN.



THE CANYON OF THE RIO GRANDE.

sils and various article of Indian camp-furniture lying about. Everything indicated a hasty departure a few weeks before. So recent had been the Indian occupancy of this region that a Texas and Pacific official was killed here in the early summer of 1880, and the locating parties in the fall of that year went fully armed ready for a brush at any moment.

The methods of work pursued by the two roads were entirely different. The Southern Pacific was built by Chinese labor and a section of finished road turned out each day. In such work the track-laying kept up with the grading, or at most only a day or so behind. Where heavy work was encountered the track-laying of necessity halted until the obstacle was overcome, and the average rate of progress was much less than by the Texas and Pacific system, where contracts for grading were let for a long distance ahead of track-laying, and grading contractors were required to finish their work before the track reached them. The labor on the Texas and Pacific was either native or Mexican and an opportunity was offered for judging of the relative value of these different classes on such work. The Chinamen do not suffer by the comparison, although the more thorough organization of the Southern

Pacific work may be taken as in some degree explaining the superior results which they obtained.

My experience with Mexican labor indicated that it is docile and easily managed, when fairly well treated. In September, 1881, a number of Mexican teamsters were employed by the day hauling pipe for a long pipe line west of the Pecos River. After a few days' trial it was found that, like any other labor working by the day, they were indifferent on the question of getting in a full day, and it was concluded to change. Pasteboard tickets were procured and furnished as vouchers, showing the number of pipe and distance to which they had been hauled. The price per pipe per mile was such as to insure, by a little promptness, as much pay as they had received in wages by the day. After two or three days' trial the new plan was found to work with satisfaction to all concerned. When pay day came, however, an interesting state of affairs was revealed. Although there were several teamsters, one man had nearly all the tickets. His associates making no objection, the cash was paid to the man holding the tickets. At the next pay day the same state of affairs existed, except that two men held nearly all the tickets this time. Finally the mystery was explained. On going into one of the neighboring saloons a few nights after, I found the whole party industriously playing the Mexican monte game with the pipe tickets as the ante.

A TEXAS LANDSCAPE.

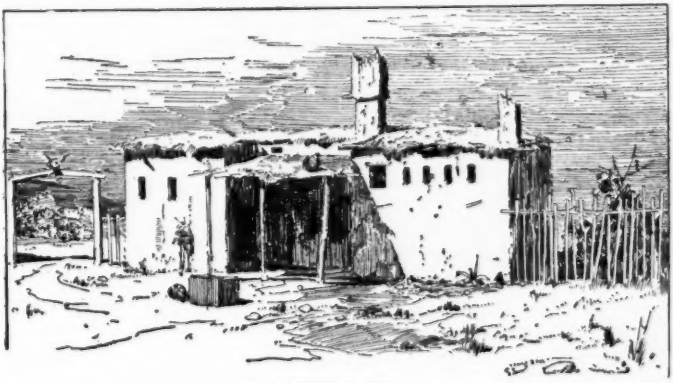
PAISANO PASS.

On the whole the Mexican laborer, even in his most objectionable form as a *greaser* on the frontier, has been somewhat maligned. Undoubtedly he has a happy-go-lucky character, is given to gambling, and so long as he has a dollar in his pocket, would much rather sit on a shady side of a *jacal* and smoke cigarettes. He has been frequently accused of possessing more than his fair share of treachery, but this appears, after some little acquaintance with him, as something of a libel. It is true that when imposed upon he is liable to come upon his enemy in the dark, and possibly take what he calls revenge by a stab in the back. But this is characteristic of semi-civilized races everywhere and those who use him kindly and respect what he considers his personal rights, need never fear the assassin's stab.

The future of agriculture in the more arid portions of West Texas lies in the development of a comprehensive system of irrigation. In the Rio Grande valley about El Paso irrigation has been in use for three hundred years, and at a Mexican settlement on the Pecos River twenty-five miles south of the Texas and Pacific, we found the hydraulics of irrigation in an advanced state. From a substantial dam and main canal the water of the river is led for several miles along the side of the valley and distributed by ditches. The canals and ditches are laid out with due reference to economic construction and efficient service, and it is impossible not to admire the skill displayed, especially when it is learned that the work was all constructed without the use of engineering instruments. The

crops raised are wheat, barley, oats, corn, vegetables and fruits. These Mexicans are, however, as much behind in their methods of cultivating and harvesting as they are in advance in their irrigation. Plowing is done by the wooden plow the same as by their fathers for untold generations. Their grain is harvested by cutting with a sickle and carried in the arms of women and children to a threshing floor of pounded clay, where it is treaded out by goats and burros and finally separated from the chaff by winnowing. Wheat is ground as needed for use from day to day, by pounding in a mortar with a pestle. Grapes are raised in abundance, and considerable wine of excellent quality is made. This is stored in skins, and an experience in an El Paso del Norte wine cellar, with rows of skins hanging from beams overhead, and lifting one down to untie a leg and fill a canteen therefrom, seems more like a romance of the Middle Ages than an actual occurrence in the latter half of this prosaic nineteenth century.

Taylor County, Texas, is the natural home of the prairie dog, and per consequence, of the rattlesnake also. The rattlesnake and the ground owl are found wherever the prairie dog lives, and there is a legend to the effect that the three dwell peacefully together in the same burrow. This I believe to be a myth so far as the rattlesnake is concerned. When he takes possession the others go out, if they can get out, leaving his snakeship in undisputed possession. The owl and the prairie dog probably do occupy the same hole. As cool weather came on in the fall, the number of rattlesnakes encountered in localities where the industry of the prairie dog had



A MEXICAN HOUSE.

furnished a home for them, was so great that I refrain from mentioning it for fear of lying under the imputation of telling snake stories. I content myself by saying that it was a poor day for snakes when one did not see at least half a dozen in a day's journey. But in spite of the large number of rattlesnakes I not only never saw a human being who had been bitten by one, but I cannot now remember ever meeting any person who, on close questioning, could truthfully say he had seen such a case. The habit of the snake of first trying to get away, and when he finds himself too closely pressed, of coiling and sounding the warning rattle, is probably the real reason why so few are bitten. Five feet in length is a large rattler, and one-half his length is the limit of striking. I presume I have come upon rattlesnakes and either tantalized them with a flag-pole myself or witnessed it by members of my party, at least a hundred times, and with one exception the snake was willing enough to retreat if allowed to. The exception was a large rattler in the Sand Hills who as we came upon him was just preparing to make a dinner of a kangaroo rat. He not only defended his dinner but advanced toward the enemy, viciously coiling and striking. It seems to me that an angry rat. tler comes nearer typifying the incarnate spirit of viciousness than any other object in nature.

In addition to rattlesnakes we made intimate acquaintance with horned frogs, striped lizards, tarantulas, scorpions and centipedes. The dangerous character which has been popularly ascribed to all these is in the main mythical. The horned frogs and striped lizards are easily tamed and make interesting pets for those who desire something odd.

Those who have never been in the Southwest will be likely to conclude that such quantities of animal, insect, serpent and other pests render the settlement of the country a slow process. But the prevalence of the stronger holds sway. Taylor County has grown rapidly in population and wealth, and now after ten years contains many hundred prosperous farms. Abilene, the county seat, is located near the Clear Fork of Brazos, and in 1880 prairie dogs, rattlesnakes and ground owls held full sway in what are now the streets of a town of four or five thousand inhabitants, with street-cars, water-works, electric lights, telephones, substantially-constructed brick and stone buildings and all the other accessories of an enterprising modern town. The chances are good that prairie dogs, rattlesnakes and the rest are already scarce in Taylor County.

The buffalo had been nearly exterminated in West Texas two or three years before the period of which I write, and in 1880 bleaching bones dotted the landscape in all directions. The number of these was almost inconceivable. In Mitchell and Howard counties one could ride for days and never lose sight of the skeletons. As the railway advanced the plains were scoured in all directions and the bones gathered and shipped east to be ground into fertilizers. I remember seeing near Big Springs a pile of bones, gathered in advance of the track-laying, at least one hundred feet long, thirty to forty feet wide and something like twelve feet in height. Many similar piles were gathered during the season of 1880 and 1881. Systematic butchering of the animals solely for the hides by large organized parties was the cause of this rapid extermination, which all who were lucky enough to see the buffalo in his native wilds must ever regret.

MARBLE QUARRYING IN THE UNITED STATES.

By E. R. Morse.

THE use of American marble within recent years has become so extensive, both for cemetery use and in buildings, that a brief description of some of the principal quarries from which it is taken and of the methods employed in quarrying may prove of general interest. Different foreign marbles, such as the African Red, Belgium Black and Mexican Onyx are employed in the interior decorations of buildings, but only Italian marble can be said to come really into competition with the American product, and the importation of this stone into the United States amounts to only about one-sixth as much in value as the marble produced and sold here. Marble is found and quarried in six American States, though in several of these the supply is too small or the quality too indifferent for the yield to be of importance. The product is practically limited at present to Tennessee, Georgia, Maryland, New York, Massachusetts and Vermont. It is not questioned that large and valuable deposits may exist elsewhere, but the expense of testing deposits is so great, and the chances that the product of new quarries may prove unsalable are so numerous, that new marble fields are not likely to be developed soon.

The marbles of Tennessee are all of variegated colors, in which the red and chocolate predominate. They are very hard, often unsound, and are used exclusively in the interior of buildings and in furniture making. The product of Maryland, Massachusetts and New York (with the exception of a small deposit known as Gouverneur and which resembles granite), is coarsely grained, of a whitish hue, and principally used in building-fronts. Several years ago much was heard about the wonderful fields of marble in Georgia, and it was thought only a question of a short time when that State would become recognized as the marble-centre of the country. It is undoubtedly true that very large deposits of marble exist there, and extensive mills for sawing the product have been erected and much money expended in placing the product upon the market. It is, however, too coarsely crystalized to be much sought after as a marble for monumental purposes and it is now mainly used in buildings. The stone ranges in color from a pink to a clouded white.

The Census Bulletin on the marble industry in this country, recently issued, shows that of all the marble produced, for whatever purpose, Vermont furnished more than 62 per cent., and of the marble used for monumental purposes alone it is probably safe to say that at least 90 per cent. is quarried among the Green Mountain hills. Although the deposit extends through a considerable portion of the State, it is only in a comparatively small part of it, Rutland County, that the most valuable quarries are found. It is a curious fact that towards the north of this county the stone is much finer grained, evidently having been subjected to greater pressure and heat, and in consequence it is very seldom that sound marble is obtained. It is usually very reedy, or else filled with tight cuts, so fine that they are not discovered until the marble is sawed, and then an apparently sound block will break into a thousand pieces. So finely grained and beautiful is this stone that numerous attempts have been made to quarry it, the result being financial disaster in every case. Toward the south the reverse is true, the marble proving very sound but gradually becoming so coarsely crystallized that it is suitable only for building purposes.

Although at different times various theories have been advanced as to the origin of marble, the now well-established opinion seems to be that ages ago the whole Green Mountain section, even as far as New York, was an arm of the sea; that the various rocks of this region have resulted from sedimentary deposits in sea-water; and that marble is made up of the remains of shell-fish and corals, changed and hardened into its present condition by tremendous pressure and heat.

To possess merit marble must be of fine grain, hard and susceptible of a high polish. It is this latter characteristic that distinguishes it from limestone, now found so abundantly. Marble worth the sawing is very rarely found until a depth of from twenty to forty feet has been reached, and it does not then follow that the quarry may have any real merit; heads, cracks, tight cuts, and a predominance of inferior stock may all develop to make it necessary to "dump" the blocks even after being quarried. Throughout the marble region it is not an infrequent sight to see abandoned quarry openings, into which thousands of dollars have been poured by people carried away with the stone craze.

If an outcropping of marble is found that looks favorable for a future quarry it is first bored, as a rule, with a machine specially constructed for this purpose, to ascertain if the deposit has any

depth and is of suitable quality and color. This machine consists of a hollow steel cylinder having its outer rim thickly studded with black diamonds. This cylinder being driven into the stone, either by hand or steam power, cuts out a small core, from which the quality and color of the stone can readily be judged. The writer once knew a gentleman who was marble mad. Positive that his farm was teeming with marble, he spent all his time and considerable money in taking out cores from every ledge. His display of these was truly beautiful, and judged by that alone he did indeed possess a fortune. Notwithstanding all the indications were against finding sound marble, his enthusiasm was such that he easily induced New York capitalists to invest largely. With the exception of their experience all they have to-day to show for their investment of a few hundred thousand dollars is an abandoned quarry opening and a once fine mill rapidly going to decay.

Great care must be taken in getting out these cores to bore through the layers and not with them. Within two years past a quarry was opened in Vermont, extensive mills built, and all the arrangements made for doing a large business on the strength of very beautiful white cores of unusual length. But the fine statuary quarry from which such beautiful marble was to come turned out a dismal failure, the good marble all being confined to one thin layer, from which all the cores had been taken, they having been bored with the grain. This merely illustrated that while the core is an aid in determining the worth of an opening, it is nothing more and must be taken in connection with the opinion of experienced experts. The soundness of a deposit can be proved only by opening, and the opening of a marble quarry is laborious and expensive. From $40,000 to $75,000 has been spent upon several of the West Rutland openings before stock that would even pay to saw has been taken out.

A quarry is first stripped of its top rock, usually limestone, by means of small blasts, great care being taken that the charge does not penetrate into the marble. Channelling machines are then put on to cut the layers into strips of the requisite size, being operated by steam or compressed air and cutting a channel very fast. Various machines are in use for this purpose. On a straight floor with the marble lying horizontally, or nearly so, the Wardwell double-lever machine, or one similar in construction, will probably cut the most rapidly of any. This machine consists of two very heavy series of drills, on each side of the machine, working up and down automati-

cally as the machine moves slowly forward on its track. These drills chip out with each stroke a small channel, the depth to which they cut being regulated by the thickness of the layer. Where there is little danger of striking flint and the marble is not too hard, the diamond borer is used successfully. This machine operates by means of a steel head into which are set black carbons in such a manner that when the head revolves every point is covered by the carbon. This head feeds down on a spindle making 1800 to 2000 revolutions per minute, and bores down very rapidly. The layer being reached, the spindle is rapidly withdrawn and the same process repeated, a web-like channel being made. The quarry being cut up into strips, a cut is made at each end, and one set of key blocks, as they are termed, are cut and removed. This gives a chance to get to the bottom of the layers that have been cut. Steam drills are then used to bore holes into the bed of the layer at intervals of eight to twelve inches, and into these holes iron wedges are driven. In this way the entire floor is freed from its bed, and it is not unusual to see a strip of rock fifty feet or more in length raised in this manner. By the same process the strip is cut into blocks of the size desired.

No powder is used in quarrying marble, although it is sometimes very sparingly employed in removing scales and scalps when the layer has not raised evenly on its bed. Where the marble lies at an angle tunnelling is resorted to, instead of removing the immense amount of top rock that would otherwise be necessary. To do this powder is used. To avoid shattering the marble in any way a channel is cut into the side of the rock, and just above the good marble to be taken out a large number of small blast holes are put in. The cut which has been made prevents the powder from shattering the marble below, and a sufficient space is thus made upon which to place a machine to cut the underlying layers. It is usual to tunnel during the winter months, because, although quarrying is carried on throughout the entire year, it cannot be done either as cheaply or satisfactorily as in summer. The channel cuts get frozen up and have to be thawed out by steam before the layers can be raised, as marble that has any frost in it is very brittle and is liable to tear up in the raising. The development of this industry is marked by nothing so much as the improvements made in quarry machinery in the past few years. Less than thirty years ago all marble was quarried by hand and it was not an unusual sight to see a quarry swarming with men, each with his long steel

drill striking away at the stone from morning until night, and cutting deeper and deeper until finally the point was reached from which the rock could be raised from its bed.

The deposit known as Rutland marble is all contained in an area of less than half a mile. The hills embracing this deposit are so barren and poverty-stricken in appearance that the story goes that the entire tract was traded for an old horse to the man who first opened the quarries there. Be that as it may, the spot from which is now taken annually from 15,000 to 20,000 blocks, and which, to reduce to merchantable shape, furnishes employment to a small army of men, was at that time considered practically valueless. Looking up the valley one sees an innumerable network of high derricks securely fastened with heavy wire ropes, their huge chains ever and anon straining under the weight of the heavy blocks they are silently pulling up from the quarry below.

In the Rutland deposit some fifteen different layers have been uncovered to date, varying in thickness from two to ten feet, and varying also in color, texture and value ; nor is it unusual to see the same layer produce several different varieties and colors of stock. At the surface the marble lies at an angle of about 45 degrees, but after reaching a depth of from 150 to 200 feet it suddenly turns and is found lying almost flat, so that one can readily see that at that depth, to get the same marble that was found at the surface, it is necessary to tunnel far into the hills. The tremendous stone roof which is thus formed is supported at regular intervals by enormous piers left for that purpose as the quarry is taken down. In early days the quarrymen in their desire to get all the marble, and ignorant of the support necessary to sustain these heavy roofs, did not leave sufficient piers, and in consequence within the past few years in several of the quarries large masses of rock have fallen, with serious and sometimes fatal results. On a winter's day the rising steam and mist in one of these huge caverns seem to give to every object a distant and uncanny look. Here and there the gloom is broken by the glimmer of the electric light and the red fire from the blacksmith's forge as he blows the deadened coals into life. And if perchance the echo and re-echo of a blast is heard as it sounds and resounds between those solid walls of stone, one can almost imagine that he is with Mephisto in the infernal regions.

Sutherland Falls marble is all obtained from one quarry, the largest single quarry opening in the world. It is located in the vil-

lage of Proctor, Vt., a beautiful place of some 2500 people whose sole occupation is the production and working of the marble quarried there. A better place cannot be found from which to study the development of this industry, for everything in the way of machinery for saving labor is employed here.

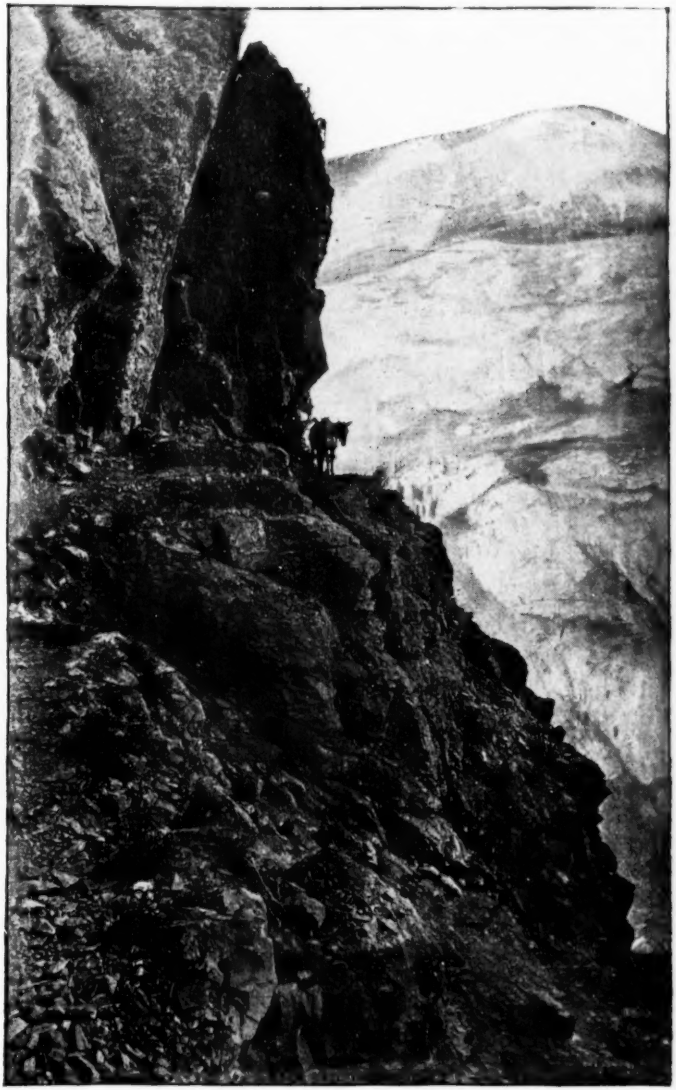
Let us glance for a moment at the methods in vogue in Italy. Almost surrounding the city of Carrara and within a few miles of it is a high mountain range, bare of trees or vegetation, and containing the marble quarries of Italy. These quarries, some four hundred in number, are scattered through the mountains, beginning near the base and extending up the sides from 3000 to 3500 feet. So inaccessible are many of them that the descent into some is by means of ropes, and in others the men do all the work while suspended in mid-air. The entire quarrying process is most primitive, no machinery of any kind being employed. Hand drills are used to put in a hole in the face of the ledge. This is filled with powder, the charge exploded, and the quarrying is done. Unless unusual care is taken huge blocks are frequently detached and go rumbling down the mountain side, putting to flight any one who may be in their path. It often happens that the blast only detaches pieces that are too small to be of any use, and even in the huge boulders the powder that has been used is very apt to penetrate and check the stone so that it is worthless, although the damage it has done may not be discovered until years after, and until the marble has been exposed to the action of the weather. The boulders that have been tumbled out in this way are next put into shape by men with a hammer and chisel picking them over and knocking off the rough pieces. Blocks of unusual size are divided by sawing. An iron saw operated by two men, much after the manner that we saw logs, except that there are no teeth in the saw, is used. Sand and water are applied, and gradually the saw is driven through the block. The blocks are next transported on huge wagons drawn by half a dozen yoke of poor, ill-kept oxen to the railroad or the harbor a few miles behind. The life of these laborers is indeed a hard one. Many start for work at sunrise and leave only when darkness makes it necessary, and for their work receive from 25 to 45 cents a day, a pittance so small that it is a wonder how they live. Such in brief is the Italian quarrying industry. Compare it with the same kind of work as carried on at Proctor, and the difference is simply the difference between the results of American ingenuity and push and of Italian superstition and ignorance.

MODERN TYPES OF GOLD AND SILVER MINERS.

By Albert Williams, Jr., E. M.

THERE is enough that is picturesque in the miner of gold and silver to preclude excuse for the absurd caricatures presented on the stage, in literature, and in pictures. At his work the miner is sensibly equipped for it; elsewhere he looks much like the average of his fellow-men. Red-shirted miners have been seen, and they wear boots and tuck in their trousers when occasion demands, but the supposed cow-boy air given by the sombrero, the cartridge-belts and the obtrusive army revolver, must be sought in the cheap drama rather than in the mining-camp. Poetry and romance are not lacking in the life of the miner; there is, however, a routine existence connected with his position as an active factor in human society which forms no part in the popular conception of mining life. There is no common type of the miner. There is a great difference whether a man is working for wages, or for himself, or is an officer of a company, as to how he lives—though all these are "miners."

Not every man can be a skilled miner. Some soon reach the limit of their capacity, and stop there. Simply to swing a heavy sledge in awkward positions requires strength, endurance and some practice, but this is only a rudimentary detail. To judge of the proper position in which to put in the "shots" most effectively, to gauge at a glance the strength of roof and the timbering needed, and to keep the workings accurately "lined up" are requirements above those of the average artisan. A good miner should have an idea of rough surveying. He should also have some notion of mineralogy, so as to be able to recognize ore when struck, to separate it when stoping and hand-sorting, and, of course, to identify it in prospecting. There is much to be done about a mine which does not call for a higher degree of intelligence than to spread ballast on a railroad track; but there are also some points involved which give a new man a good deal to learn. Miners do not all mine. That is, only a certain proportion, perhaps not over one-half, are actively engaged in pounding a drill or doing the other work which according to the popular conception constitutes mining. In a small mine the division of labor is not carried to any minuteness, and the few men readily exchange tasks, but in a great mine where hundreds of men are employed there is a very definite system, resulting in a



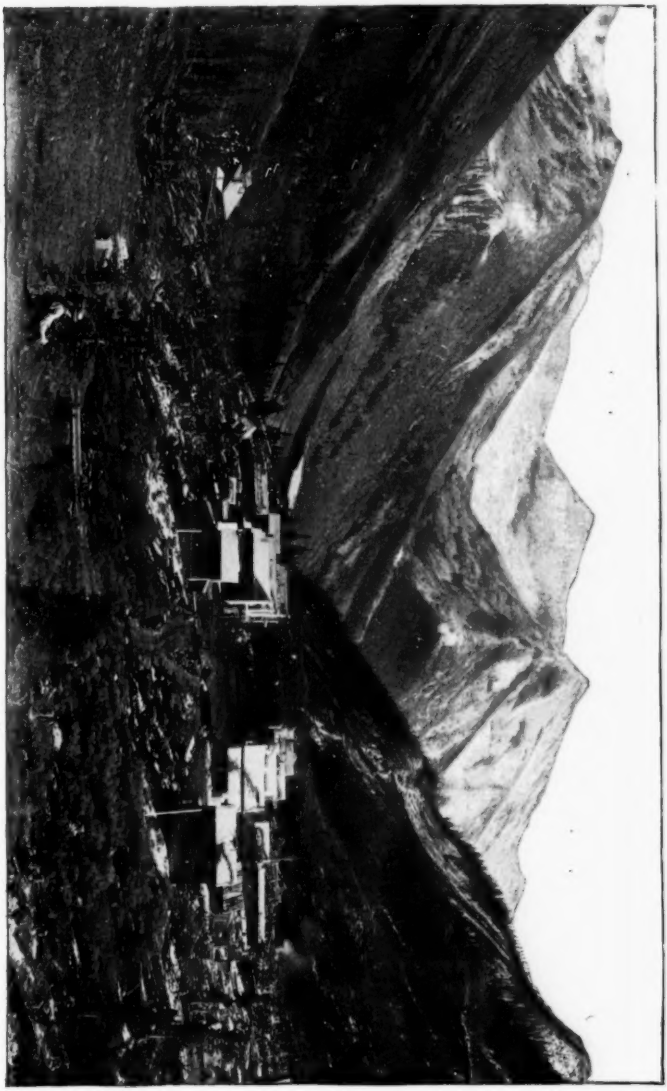
MINE TRAIL IN THE MOUNTAINS.

close classification. A large part of the force is not actually mining, yet the work of each has its bearing on the final result, and all the men contribute their share.

Miners have been famous migrators. Not only the prospectors, who are proverbially restless, but all other miners as well, travel a great deal. A man who has been in the mines for ten years may have worked in half a dozen States and twice as many camps, which cannot but have the effect of broadening his ideas. The attrition with so many other men and the frequent changes in his surroundings are a sort of education in themselves. Those extraordinary hegiras called "mining rushes" are far less frequent and on a smaller scale than in the old days, when 10,000 or 20,000 men would start off on a frantic race for the scene of new discoveries about which they had no definite knowledge. It would take a very startling find now to excite an old-time rush. Although it is so much easier to move from point to point now than formerly, since the railroad goes almost everywhere, there is less disposition to roam about.

The traditional prospector will soon be as extinct as the dodo. He was a picturesque character in fiction and in reality, and he will be missed. His disappearance will not be due to the absence of ground to be prospected, but to the different conditions under which such work is now done. In early times the prospectors were literally gold-seekers; they were after surface placers. It takes but a little time for enterprising, hardy men to overrun a considerable territory in the search for this class of deposits, easily discoverable by simple panning tests here and there, and only to be looked for in certain topographical situations, and the country has been so thoroughly gone over that the likelihood of finding anything of importance in the way of placers has been steadily lessened. The prospectors of to-day give their attention mainly to veins and lodes—deposits "in place," which are much more difficult to locate. The pioneers used to cover great distances, undergo almost inconceivable privations and hardships, and at times face dangers from hostile Indians. Now it is found that the immediate neighborhood of one's own camp is about as likely a place to prospect in as one farther away, and many of the best lode strikes have been made in the heart of districts where mining had been going on for years.

There is a fascination about mining life which, once having possessed a man, cannot easily be shaken off. A miner who has made



A MINING CAMP.

a good stake by selling his locations at first proposes to himself to travel, then to settle down in his own original home; but after a little while he discovers that he himself has changed, that old ties have been broken and that he is disappointed in his former associations. Things at home seem to have inexplicably dwindled. An almost irresistible impulse, a transferred nostalgia, a longing for the clear, bracing mountain air and the liberal ways of the mines, then seizes him. It is difficult to content one's self with the monotonous life of the staider communities after having tasted a more exhilarating one. The attraction of the mines is not all in

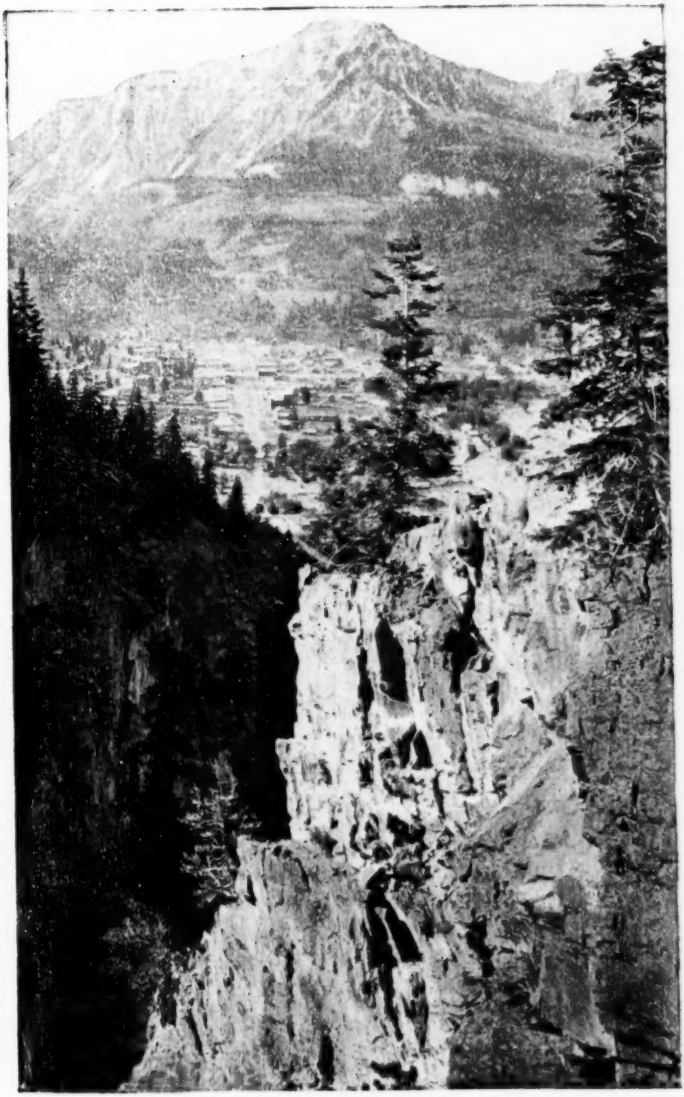
SURFACE PLANT OF A SMALL MINE.

the hope of gain, though that of course has much to do with it. The friendships formed, the freedom of thought and custom, the spirit of *camaraderie*, and the entire absence of commercial competition have their influence as well. So numbers of men, having acquired a competence in mining, make their headquarters still in the mining country as a matter of preference, not necessity. Such men are much in the habit of taking short trips away, and are to be met with all through the highways and byways of travel. To be able to lead this pleasant, independent life is the dream of the less fortunate ones. Miners are very apt to disparage their calling while they are actively engaged in it; they may term it "a dog's life," but let them once be freed, mark how they hanker after it!

MINERS AT HOME.

Nationalities are various, but the West is not yet overrun with hordes of Hungarians, Poles and Italians, and of course no foreign contract labor. Public sentiment is strong against any such invasion. Besides native Americans, there are Cornishmen, North-of-England men, Irishmen, Scotchmen, Germans, Scandinavians and Mexicans. The Latin race is but sparsely represented, and colored miners are hardly ever seen in the West. On the Pacific slope a few Chinese are employed on surface work. There are large numbers of Chinese placer miners, however, working on their own account, in California, Idaho and Montana. Of the Caucasians no figures are available as to the relative proportions of the different nationalities. The numerical order may possibly be native Americans, Irish, Germans; but this is only a guess. There are no colonizations of men of the same nationality, but the mixture of races appears to be about the same all over the mining country, except that the Mexicans do not go much into the upper tier of States. The best of feeling generally obtains between different nationalities. It is natural that the men of the different shifts should prefer to work with a gang of their own sort. Probably "Cousin Jack" is the most clannish in this respect, but that proclivity gets rubbed out of him in the West after a bit. Individual differences in point of efficiency are of course more marked than racial peculiarities, but it is noticeable in gold and silver mining that such work as is done by the engine-men, machinists and carpenters is more likely to be done by Americans than foreigners, and the former are to be found at the front in opening up new fields and among those who work their own claims. Most of the Cornishmen and North-of-England men were miners before coming to this country, and are excellent drillers and timber-men, though rather set in their ways.

Wages differ according to the character of the work and the locality. For a long time $4 per eight-hour shift was the standard for skilled miners; now $2.50 to $3 will command the same class of labor. The lower cost of living offsets the reduction in wages, and if a comparison is made between the $10 and $15 a day rates of 1849 and those ruling to-day, it might be shown that the ratio of earnings to living expenses was not much, if any, better then than now. Engine-men, machinists and blacksmiths at a large mine receive more than the miners; in the small mines about the same. Common labor about a mine is paid for at the same rate as for equivalent work outside in the same place, or possibly a little



A COLORADO MOUNTAIN VIEW—OURAY IN THE VALLEY.

RECREATION AT A WINTER CAMP.

higher, ranging from $1.50 to $2.50 per day, with an average of about $2. In Nevada and Alaska rates are highest; in Arizona, New Mexico, Utah, Idaho and Montana, they are nearly equal; in Colorado they are a little under the average, but not so low as in California. Then there is a difference according to length of shift. When a company is pushing three eight-hour shifts per twenty-four hours the men are expected to work smartly.*

Sometimes, in remote camps, the companies board and lodge their employés, in which case the wage scale is equitably adjusted. It is a very rare thing for a gold and silver mining company to keep a store, and the plan would be only a nuisance to the officers and no advantage to the men, since the enterprising store-keepers are ever pushing into the newest districts and competing. Nor, with

* The following table gives the wages of gold and silver miners and average number of days employed during the Census year 1890:

Above ground.	Average wages per day.	Average number of days employed per year.	Average wages per year.
Foremen or overseers	$4.03	215	$866
Mechanics	3.55	246	967
Laborers	2.45	197	512
Below ground.			
Foremen or overseers	4.16	238	981
Miners	3.07	233	726
Laborers	2.07	238	496

Total average earnings per person employed per year, $749.

very few exceptions, is a compulsory deduction withheld from wages as a fund for accident insurance and medical treatment, as is frequently done in iron, copper and coal mining. The "Unions," where they exist, partially attend to this; but it is also common for the comrades of an injured or deceased miner to come forward generously with aid.

Miners are not provident in the sense of laying away money in savings-banks. That seems too slow. They gamble in mining stocks and "take flyers" in the hope of "making a deal" by selling a "property" to English and Eastern investors. Sometimes they win; usually they don't. Their best investment is in development work on their own locations, if they have any, for the purpose of securing a competence from regular mining, as so many have done. Or they often do well by taking a lease and employing others to help work it. The writer has in mind the case of two men who by their own unaided effort had thoroughly opened up their claim on three adit levels. It took them nine years to do so, and they had to work at intervals on day's pay for a company to obtain means with which to buy powder, timber, tools and provisions at their own claim, from which they extracted no ore except what came out in driving the tunnels and connecting them. But they had the mine in good shape, and finally sold it for $95,000. Such instances are not uncommon. They differ from lucky strikes and come nearer to the savings-bank idea

A GOLD QUARTZ PROSPECT.

A BURRO TRAIN—READY FOR THE START.

than almost anything the miner does with his labor and earnings.

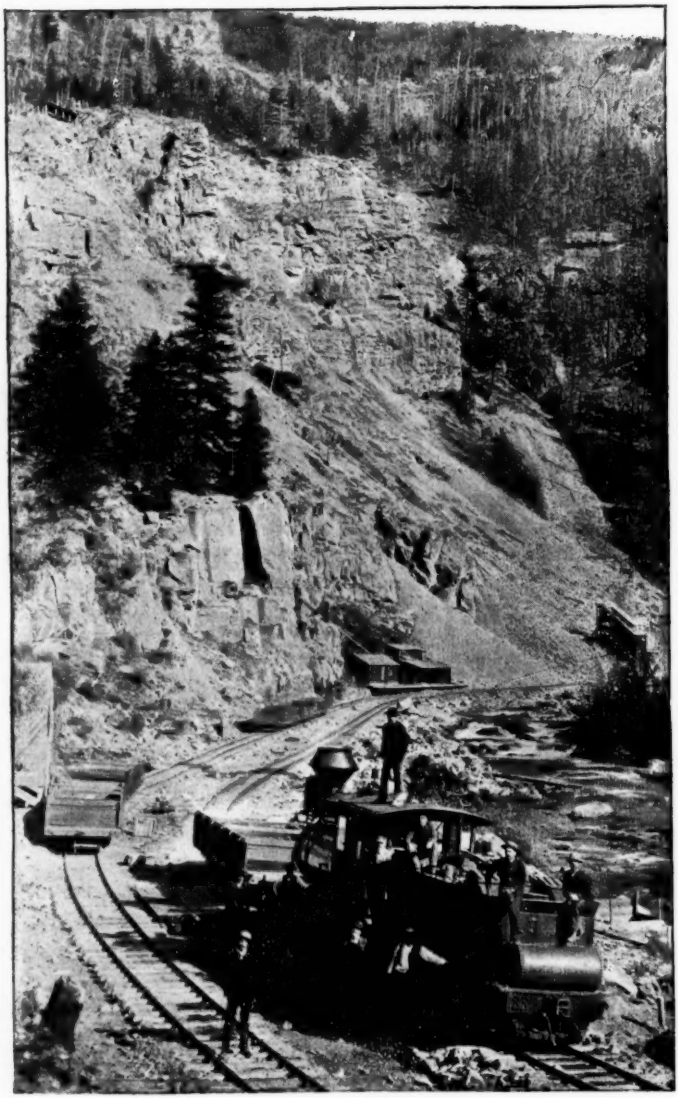
The staple articles of food in prospecting and at remote camps are beans, bacon—often of the grade locally known as "sow-belly"—flour, baking-powder and coffee. It is wonderful what an amount of baking-powder is consumed among the mines. The ground is literally strewn with old tins, to which are added empty tomato cans, corn cans and cans for other preserved vegetables. Around the settled districts the regimen is more liberal, often profuse. In California and Colorado especially fresh fruits and vegetables are plentiful and cheap in season. The miners of Nevada are especially dainty about their meals, and in that State, wherever there is a camp of any size, a French restaurant is inevitable.

The clothing worn by miners when they are at work is necessarily rough, serviceable and far from being "dudish." Many years ago some ingenious person invented a method of riveting, not only the buttons but the seams of canvas clothes, by which process a very durable garment could be made. Suits of these riveted brown canvas clothes, with plenty of pockets and lined with Canton flannel, are just the thing for work in the mountains. In very wet mines oil-skins somewhat like those worn by the fishermen of Cape Ann are used. Where it is very hot, as was the case in the Comstock mines, the men usually worked bared to the waist, except where scalding water was falling. The hat, a soft one of course, is worn

underground as a protection against falling dirt from the roof. A specialty is made of blankets for the mountains. They are double, very heavy and generally of fine quality with long nap. The "biled shirt," that is, a white one, flourishes in the towns, but outside blue and gray flannels prevail. For travelling in winter large fur overcoats of buffalo-robe and coyote-skin are in demand; but furs of all kinds are becoming more and more expensive yearly. Miners' lodgings are not palaces. If not intended to be permanent they are simple cabins of logs or boards, sometimes in part "dug-outs," but in the large mining towns comfortable dwelling places, either private or lodging houses and hotels are occupied.

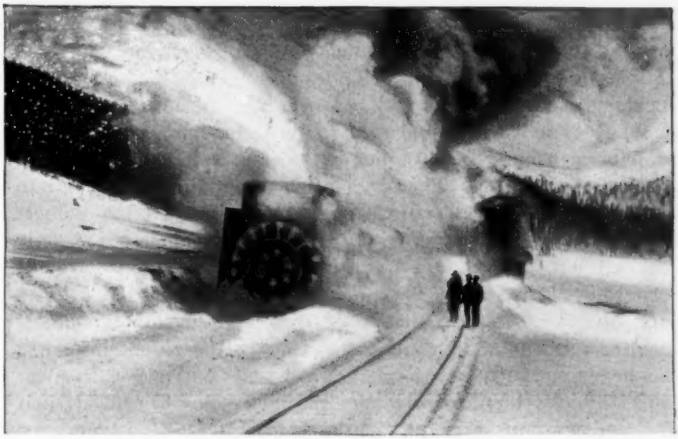
Some people suppose that a mining-camp is an unusually dangerous sort of place, full of desperadoes and "hold-ups," where every man carries his life in his hand. The misconception has been handed down from rougher, wilder times, and has been kept alive by the romancing of tender-foot newspaper correspondents. A man is far safer in a mining-camp than on Cherry Hill, New York, Tar Flat, San Francisco, or large areas in any of our cities; much more indeed than in parts of London or Paris. So far as robbery is concerned one is not safe anywhere, in the mountains or in the towns. As to affrays of other kinds a man who is sober, minds his own business and does not set up as a fighter would always be let

ALMA, COLORADO.



RAILROADING IN A MINING DISTRICT.

alone. If he does not carry a "gun," so much the better for him, for there is among the roughest characters a certain sense of chivalry, which they would call "squareness," that prevents attack upon an unarmed man. The practice of carrying arms is not at all universal in the mountains. When pistols are worn they are kept out of sight. Indeed, there is not much use to a peaceful man in carrying arms at all. If he is "held up" by the "road agents" he is always at a disadvantage, being taken unexpectedly, and when they have the drop on him a motion toward the hip pocket would be to take large chances. If the custom—so far as it goes—of



SNOW-PLOWING UP TO THE MINE.

carrying weapons may sometimes lead to unpremeditated fatal encounters, it also has the effect of making men quiet in manner and cautious about giving offense, so that even "when whiskey is talking," there is less noise and certainly less disposition for a rough-and-tumble fight than under similar circumstances in cities. Miners have too much to do to become hard customers.

Miners are omniverous readers, though they have but little time to indulge the taste. They support weekly newspapers in camps where the population is but a few hundred, and considering the surroundings and the limited circulation these local papers are very creditable. In the larger camps dailies are published, which show an enterprise in the way of obtaining telegraphic news that is not equalled by towns of four times the size in agricultural

regions. The miners also subscribe liberally to the technical journals and to the weekly editions of metropolitan newspapers. Some of them study the books relating to their calling, but as a general thing the working miners do not place much reliance on "book-knowledge," and are apt to carry their prejudice too far. Light literature, not always of the highest order, is absorbed in quantities. Miners, shut off from the outside world as so many of them are, take all the more interest in what is going on elsewhere, and are better informed on general topics than would be expected from their isolated situation.

The dangers of the gold and silver miner are mainly of his own making. There are no holocausts from fire-damp, as in coal mining, and seldom fires underground. Falls of roof and caves are also less common than in collieries, though most of the minor accidents are from falling rock. Lesser hurts result from careless handling of tools. But the men forget to look for missed shots, or, finding them, proceed to pick out the unexploded cartridges—with the usual result. Then they often absent-mindedly walk into winzes or off of level stations, or sway out against the timbers while on a rapidly moving cage. Habit makes them not exactly reckless, but inattentive. A curious fact is that mining accidents seem to occur in groups, like epidemics; and this has given rise to superstitious adages, so that when one fatality happens, miners look for a second and a third to follow. In the mountains, when the heavy snows begin to melt, irresistible snowslides, frequent especially in Colorado, overwhelm the men going to or from their work, or sweep away and entomb their cabins with the occupants.

If one were to attempt to describe in a few words a type which would broadly represent the miner's characteristics, it would be to say that he possesses the qualities of adaptability, self-reliance and resource in emergency to a higher degree than most men; that he is usually fairly informed on subjects outside of his own calling and is mentally receptive and liberal; that he is of sanguine temperament, perhaps too much so; that his tendency is to make light of hardship, and when occasion demands faces danger with a cool and quiet courage so far removed from being theatrical that the world does not appreciate it. His disposition is somewhat like that of the sailor, very much toned down. It would be a mistake to think that all miners are the same, but as a class their characteristics centre about these traits. A miner is only a man, and has his shortcomings like other men, but his faults are seldom mean ones.

THE CONDITIONS CAUSING A TORNADO.

By Prof. H. A. Hazen, U. S. Weather Bureau.

OF the more powerful manifestations of nature not one is of such absorbing interest as the tornado, with the exception of the earthquake, which is comparatively rare. It may be said, also, that none of nature's outbursts have been more carefully studied; yet it appears that many of the theories advanced are undergoing very significant modifications. The old belief that a tornado represented a terrible conflict between a cold cloud from the north and another much warmer from the south has given way to the theory that the warm air must flow underneath the cold and the unstable equilibrium thus resulting will ultimately bring about the violent commotion which destroys everything before it. The limits of this article will not permit a discussion of these, at best, rather vague theories, but our attention must be devoted to the environment of the tornado, its appearance, its work of destruction and the other facts that have been determined.

WILKESBARRE, PA., TORNADO, AUGUST 19, 1890.—SCENE ON SOUTH MAIN STREET.

BROWNSVILLE, MO., CYCLONE, APRIL 18, 1882.

One should distinguish carefully between the cyclone and the tornado. For a long time it was supposed that Western people and newspapers were reluctant to use the term "tornado" because they supposed it to represent a much more violent and terrible disturbance than the cyclone, but it now appears that just the reverse is the case. There seems to be no good reason why the term "cyclone," representing to the scientific mind a broad storm and of relatively slight violence, should not give way to the proper term "tornado." This is a very violent electric storm, of limited extent, having an indescribable roar, and often a funnel-shaped cloud.

On a quiet but very hot afternoon there suddenly appears in the southwest horizon an ominous greenish-black cloud; the sky is almost cloudless overhead and there is a gentle south wind blowing toward the general storm which almost invariably will be found to the northwest and about 400 miles away. Occasionally light, fleecy cirrus clouds, also generally from the south, pass far above one's head. Suddenly the black cloud draws near, preceded by a tremendous mass of dust, and a terrible roar, likened to "the bellowing of a million mad bulls," or to "the passage of ten thousand trains of cars through a tunnel," is heard. This characteristic roar is usually heard at least fifteen minutes before the arrival of the tornado, and in conjunction with other signs gives ample warning of its approach. The cause of this roar it is not easy to determine. It is like a continuous roar of thunder, it is with-

out doubt some manifestation of electricity, and it has been heard in a violent thunder-storm. The wind now blows violently from a western point, but it is hardly proper to say that it shifts to the west, as the cause of the west wind has no connection with that of the previous current from the south. Almost immediately the tornado, often ushered in by a fearful pelting of hail, is upon us. On the south side the destruction extends oftentimes to 1000 feet or even a quarter of a mile, while on the north side one may stand with impunity within 400 or 500 feet of the greatest destruction.

On page 67 we see the conditions of the atmosphere just preceding the most violent tornado that has visited this country—the Louisville tornado of March 27, 1890. This chart shows isobars, or lines of equal pressure, circling about the general storm central to the northwest of Louisville. This chart merits careful study, for it presents a typical case of a tornado. As will be noted, the tornado tracks are represented by the short lines near Louisville, Ky.

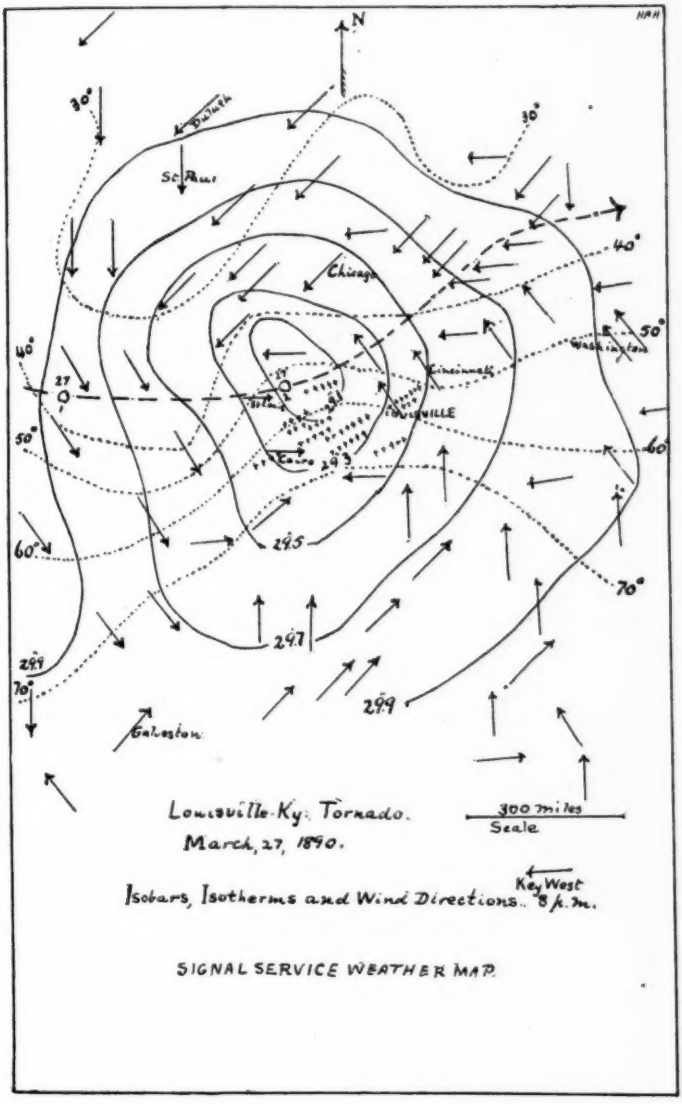
The velocity of the tornado is nearly double that of the general storm, which shows that its movement is not due to the onward progress of the upper current. Moreover, as we have just seen, this upper current is from the south, while the tornado advances

WALTERBORO, S. C., APRIL 16, 1879.—RUINS OF DR. DUNWOODY'S HOUSE.

from some westerly point. The cause of this enormous increase in velocity is not easy to determine. Though many facts point to its origin in the tornado itself, it certainly cannot by any possibility be due to a convenient upsetting of the atmospheric equilibrium just in front of the storm and nowhere else. The readers of this magazine who reside in the East will recognize in the above description a great similarity to the more violent thunder-storms to which they are accustomed, and in fact a tornado has been aptly called the extreme development of a thunder-storm. If this view could be firmly established it would give us a most important guide for future studies, for the latter storm can be readily studied and does not terrify the beholder. In a thunder-storm we find, from the evidence of scores of barographs, that the pressure almost invariably rises; from wind directions, that there is a down-rush in the centre and an outrush on all sides; and we also find frequent heavy hail falls. This storm presents every appearance of having its own source of energy, it travels at a velocity double that of the general storm, and is situated, as in the case of the tornado, about 400 miles to the northwest. That there is a most violent down-rush in many tornadoes has been abundantly proved by the crushing of houses, by the breaking of limbs of a tree and causing them to fall at its base, and by many other signs.

An examination of the region of tornado activity shows the existence of a large number of paths of individual tornadoes. These paths are parallel and occur farther eastward as night draws on. The earliest occurs about 3 o'clock in the afternoon, and the latest even as late as midnight. These entirely independent tornadoes, occurring so long after sunset, would seem to show that the sun's direct heat has little or nothing to do in causing them.

The fact that fowls are entirely denuded and left alive was long supposed to indicate the existence of a partial vacuum in the air. It was supposed that the sudden expansion of the air in the quills served to throw off the feathers, but experiment has shown the impossibility of depluming a fowl under such conditions. Professor Loomis attempted to determine the velocity at which the wind must blow in order to remove feathers from a fowl. He loaded a six-pounder howitzer with powder and a dead fowl, and on firing it found that the fowl had been torn limb from limb. The estimated velocity was 300 miles per hour, and it was thought that at 100 miles per hour the feathers might have been stripped and yet the body kept whole. It would seem, however, that, long

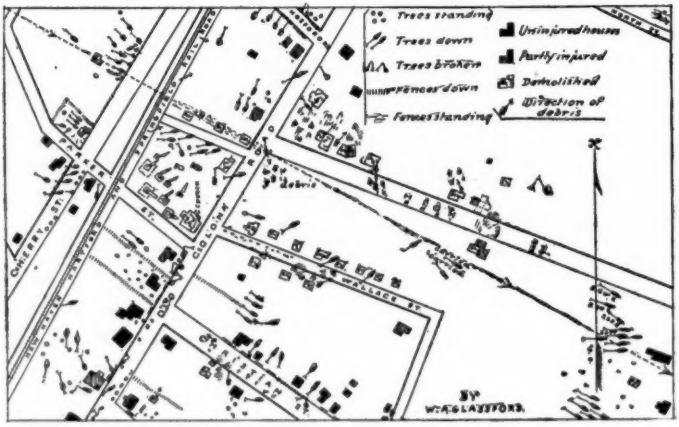

N
30°
Duluth
St Paul
Chicago
40°
50°
Washington
40°
27
Louisville
50°
60°
29.5
70°
29.7
29.9
70°
29.9
Galveston
Louisville Ky. Tornado.
March, 27, 1890.
300 miles
Scale
Key West
Isobars, Isotherms and Wind Directions. 8 A.M.
SIGNAL SERVICE WEATHER MAP.

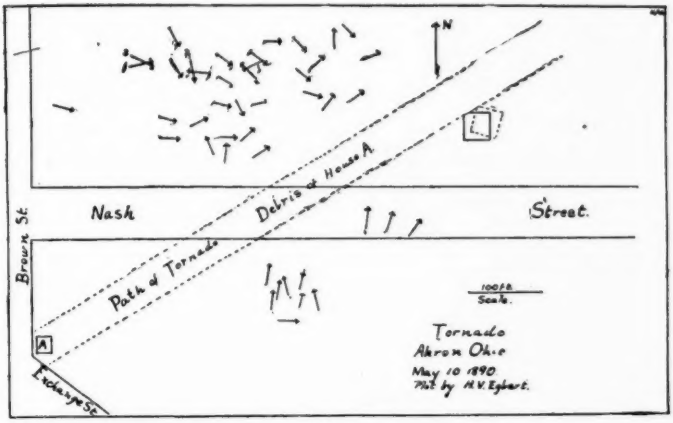
before the wind velocity could reach a point at which the fowl would be deplumed, the whole body, feathers and all, would be carried away.

The fact that houses sometimes present the appearance of having been exploded is also advanced as a proof of the existence of a vacuum in a tornado. It should be noticed that this appearance is often found at some distance from the tornado-centre, while the partial vacuum, if there were one, would not extend so far. A striking illustration of the supposed influence of a vacuum was developed in the tornado at New Ulm, Minn., on July 15, 1881. A large family were seated about a table, and as the tornado came up nearly every member of the group declared that he or she had experienced a very oppressive feeling which was instantly relieved when the sides of the room exploded outward. Now this was evidently advanced to prove the existence of a vacuum, but a little thought will show that the effect must have been from an exactly opposite cause. So long as the vacuum was outside of the house, no one inside of it would experience any sensation whatever, but after the house exploded there ought to have been an oppressive feeling owing to the vacuum. On the other hand, if there had been a *plenum* in the house there would have been an oppressive feeling which would have been instantly relieved upon the explosion.

In the whole range of questions concerning tornadoes, perhaps

Tornado Path through Wallingford, Connecticut.
August 9, 1878





the most interesting and important is that relating to its whirling. The argument has been advanced that we could not otherwise account for the tremendous violence of the blow that destroys everything in its path. This reasoning is not well taken, and is no argument. The existence of the whirl should be proved first, and if this cannot be done we can afterward investigate the source of the power. The distribution of débris has also been advanced as a proof of the whirl. This is so important that these several illustrations are given here, showing this distribution of trees and débris very clearly. On page 68 is a map of a portion of the destruction in the tornado at Wallingford, Conn., on August 9, 1878. A careful examination of the track shows a most marked tendency throughout its whole extent for the trees and débris on either side to arrange themselves pointing inward toward the track and forward in the direction of the tornado. In the exact centre, where we would expect to find the most marked evidences of a whirl, there were none at all, for all timbers and trees lay parallel and along the track as though a mighty river had flowed that way and left the driftwood in its centre. The map on page 69 represents the direction of trees on either side of the track of the tornado at Akron, O., May 10, 1890. This map was carefully made with compass pointings by Prof. H. V. Egbert, and shows accurately the exact positions of the trees.

It has been said that individual trees show spiral splinters, or, again, that they show an appearance as though the first bend-

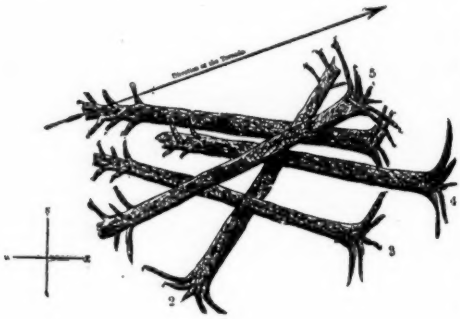


Fig 3.

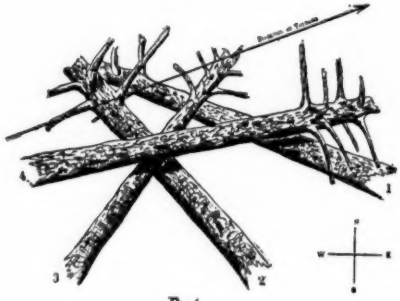


Fig 4

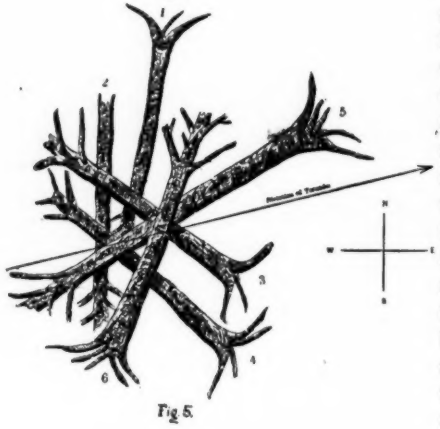


Fig 5.

ing had been toward the tornado, and afterward the whirl had twisted the tree around until it assumed the position so often noted. If any such action can be substantiated it would be the very best proof that it was not produced by a whirling cloud. The whirling cloud has a diameter of 300 or 400 feet, and its only action could be to blow down in a spiral form all the trees in its path. There is no possible way in which this enormous whirl could take hold of an individual tree and twist it around. Figures 3, 4, and 5 will illustrate my meaning clearly. In all cases the tree numbered 1 lies with its top pointing toward the west, and the successive trees fall more and more around by north to the east. This is the law, but a little examination will show that, however we may account for

these individual whirls or freaks of the tornado, they can by no possibility be explained on the supposition that they are caused by the grander and more extensive sweep which comprehends all the smaller freaks.

An universal belief prevails that there is a powerful suction toward the funnel cloud and upward-rush in its centre. It is difficult, on this supposition, to account for the fact that often a frail structure, like a chicken-coop, is left intact, while near by a strongly-framed house is dashed to pieces. It should be noted that objects are not sucked up into the vacuum, as many believe. If a vacuum should be formed over a stone, or any heavy object, it would really weigh more than before and cling to the earth more strongly. The only way in which a vacuum could act would be by inducing a rapid current of air, and this violent wind would bear aloft the heavy object. It is not difficult to consider that a most violent wind would tend to carry objects forward and upward, and such action has been repeatedly noted in the straight line winds of a thunderstorm. Right here is a most important consideration. If the destructive action in a tornado is due to a whirl, then the tendency of objects in the fore-front of the whirl would be to the left, and not directly forward as has been universally noted. The velocity of the current, if the destruction is due to a wind-rush, has been variously computed from 200 to 1000 miles per hour. One of the best ascertained velocities was at the Wallingford tornado in Connecticut, where gravestones were pushed off without chipping either the pedestal or the bottom of the monument. A careful computation showed that the velocity in this case was not far from 260 miles per hour. In the Ohio tornado at Washington Court-House on September 8, 1885, a velocity of from 250 to 300 miles per hour was determined. This application of force in wrecking and throwing down houses, trees and monuments, should be most carefully distinguished from the forward rush of the tornado which rarely is greater than eighty miles per hour. At the same time, this tremendous velocity cannot be due to a high wind, properly speaking, for the object is rarely carried more than a few feet which could not be the case if it was borne along by a wind of 260 miles per hour.

The destructiveness of tornadoes has been very much overrated from the fact that no distinction has been made between the loss from high winds and that from hail, rain or floods, and also between the definite loss to structures and that of crops, orchards and

LITER, ILLS., MAY 18, 1883—RUINS OF DR. GRIFFIN'S HOUSE.

timber. All the destruction has been put together in a grand total and has been applied to loss on structures. In this way a loss nearly twenty times too great has been estimated and used by tornado-insurance companies in their figures. Another way of estimating the relative loss is by comparing loss from fires with that by tornadoes. During the years 1876–84, the loss from tornadoes, in the more important States, was only about one fifteenth of that by fire. These figures are very interesting when we learn that many companies have made the tornado premium almost exactly the same as that for fire. The hazard from fire loss is ever present and quite well determined, while that from a tornado is exceedingly rare, and, in all but four or five of the States, so slight that no one need think of insuring against it.

The loss of life from tornadoes, it is believed, has been much exaggerated in the minds of most people. Professor Loomis, forty years ago, determined the average loss to be one to each tornado, and a more recent careful computation has shown that that estimate was not far wrong. An interesting comparison may be made between the loss of life by lightning and by tornadoes. During 1890, about 120 persons were killed by each, while, up to September 2, 1891, it is reported that 205 have been killed by lightning and only 95 by tornadoes. Deaths by lightning are scarcely noticed in the newspapers while those in tornadoes are usually considered

very much greater in number and are treated with far greater seriousness.

An attempt has been made to separate tornadoes into three classes, according to their destructiveness. Of Class 3, the most destructive, there have been 61 since 1872, with an average loss of $200,000 for each; of Class 2, there were about 1000, with a loss of about $20,000 in each case; and of Class 1, there were about 1000, with an average loss of $3000. A careful compilation of all the tornadoes reported by the newspapers of this country during the past two years has shown that in more than two-thirds of the cases severe thunder-storms or wind-rushes have been mistaken for tornadoes. In a great many cases a careful inquiry into the loss sustained to structures has shown it less than $100. If there is good evidence of a straight blow in a thunder-storm it should be called a "wind-rush" or a severe thunder-storm, and some estimate should always be given of the probable loss to buildings. The customary newspaper sensationalism in this line seems far from desirable. The only way to counteract this wrong estimate of the violence of our western storms is to keep a sharp look-out for them, to investigate each one separately and give it its proper value.

As our western country increases in population it becomes a live question as to proper warning and protection from the ravages of these severe storms. There is always danger of exciting too great

ROCHESTER, MINN., AUG. 21, 1883—RUINS OF AN ELEVATOR.

fear by attempting any warning, but it would seem that a simple warning of severe thunder-storms might be sent out by the central office of the Weather Bureau, and this should serve, not to terrify, but to put the people on the watch for local signs of the approach of a tornado. A cellar as a general thing would be ample protection, though elaborate caves have been proposed for protection. In the open air there is usually an abundance of time to run to the north side of the track. The safe side if one does not see that it is about to pass well to the northward of his position. It is a most remarkable fact, which has been established in scores of cases, that a tornado will frequently occur during the busiest part of the day and very few people will be injured. In Wilkesbarre, Pa., last year, a tornado passed through a very busy section of the city where many thousands were exposed directly to its onslaught, and yet only sixteen lost their lives. One reason for this immunity is the fact that the unmistakable roar gives ample warning and leads people to seek places of safety.

Can the energy of the tornado be diminished or be entirely dissipated? This is destined to be a most important question in our western States. If it is possible to dissipate water-spouts by concussions of gunpowder why may not the energy of a tornado be dissipated? Of course there would be a practical impossibility in making explosions just at the right time and place, but the plan does not seem to be entirely chimerical. It is believed that, in general, the existence of a large wooded country to the southwest and west of a town forms a good safeguard against the development of the most destructive tornadoes. Since almost all the severer of these storms come from the southwest, it may some time be found entirely feasible to station watchmen at the distance of a mile or two to the west and southwest who could give ample warning, for special strokes on a bell, when a tornado was likely to cross the town. The fact should never be lost sight of, however, and should allay a great deal of anxiety in the minds of the most timid, that all the severe tornadoes give ample warning of their approach.

It will no doubt appear that in all this a good deal has been said about tornadoes, but no consistent theory of their mechanism has been given. This is true, and in the minds of many it would seem that we can do little more at present than say what a tornado is not. Until we can investigate the conditions of the atmosphere at the spot where the tornado obtains its energy, we must continue to grope in the dark and to add to our knowledge little by little, hoping some time to obtain a clear idea of its formation.

THE FUTURE OF OUR WAGON ROADS.

By William Claypoole, C. E.

THE rapid development of internal commerce which has been promoted by the extension of steam railways has produced so strong a current of activity through all the avenues of human existence in North America that every successive year, in the last decade particularly, has presented some striking change and progress in ways and means of travel. Most of this activity and progress, however, has been confined hitherto to the rail. Roads having a surface of gravel, broken stone and sand have not received such a degree of attention as to lead to their extension and improvement in a creditable manner. Common roads have been eclipsed, fallen behind and thus lost in consideration and popularity. The capital invested in railways has been increasing constantly, and the stock market has been an interest commanding the attention of leading minds in every city, town, village and hamlet. Thus it has been that the wagon road, overshadowed by the railway in almost every community, has fallen into more or less neglect. Meanwhile, however, the building of carriages, buggies and wagons has not slackened in the least, but establishments all over the country, in which are invested a large amount of local capital and which employ a large number of skillful workmen, are putting out countless thousands of elegant vehicles. Improvements are constantly being made, too, in material and workmanship on these common-road vehicles.

In days gone by when the heavy mail coach with its great team of horses traversed the common highway, interest was centred in that, and the condition of the public highway was an object of public solicitude. In the loss of the mail service the wagon road suffered an irreparable injury. The influence of the general government in matters requiring attention and expenditure is very marked. Non-resident authority, controlling abundance of pecuniary means, directed by a regard for the welfare of the community at large, is not influenced by refractory individuals whose contiguous residence gives them a directive interest. In towns and cities municipal authority directs the paving of streets, presumably regardless of nothing but the interests of a majority, and lets the

work to contractors under restrictions which insure a degree of perfection consonant with an ideal which for the time being meets with public favor. Now this ideal is dependent upon local progress for its relative degree of perfection. A street upon which the buildings are models of architecture does and should receive a well-laid pavement, the adjacent property being sufficiently valuable to support it.

Outside of the limits of the town the conditions change and the value of the road is dependent upon its being the connecting avenue upon which the travel between two adjacent towns passes. In some sections of the country this travel is important and valuable, and in others less so. Along the line of some of these roads the buildings are few and far between, and the assessments are made upon residents within two miles of the road. The owner of a tract of 320 acres of land may be assessed for the building of roads which he never uses in any way. This often produces dissatisfaction, and the objection of a single large land-owner is generally sufficient to prevent improvement of a road. Farm buildings often are very indifferent, and the ways of farming very lax and inefficient, and until some impulse changes and improves these, there will be little benefit from improved roads through the farms.

In many portions of the country remote from business centres there is no interest which is sufficiently strong to induce land-owners to incur the expense of improvement. Habits of life operate very strongly against any progress in methods of farming. Many large land-owners cannot see the way through the contingencies which might arise to them from any improvement, and they therefore feel justified in being doubtful of its practicability. Education would in most men alter their sentiments in this regard by causing them to appreciate other ways of life and other forms of property, and thus leading them into change and progress. Where the influence of city life, its manners and activities have penetrated into the rural districts a demand for new articles of use and ornament soon obtains a hold, and new ways and methods are introduced. The result is new activity in the affairs of life, and luxury often succeeds privation. The wealth of the city community has in all civilized countries increased in proportion to the advance of the age in Art and Science. In a country remarkable for fertility, however, man should not be confined to the city limits, but, passing the barriers, be found a producer in the fields. Such is the fact. Agriculture has kept pace with art and science, and yet so large is the

field of effort her great advance has seemed dwarfed in comparison. New necessities call for new effort, and there can be no letting up in the great struggle of life and industry. Vast tracts of land are yet open to the pioneer of improved methods in horticulture, floriculture and agriculture. These vast expanses are inaccessible without avenues of travel, and engineering science demands that wagon roads should be built with good alignment, easy gradients and superior surfaces. Thus it is that in the eye of the skillful engineer many of the common roads in existence are lacking in all the essentials of a good road. The alignment has been chosen without any care, and the gradients are steep. The surface, too, is soft, loose and rough, thus entailing upon every vehicle and horse passing over it wear and tear and exertion.

Still there are many good roads in existence. For example, in the blue-grass region of Kentucky, where the raising of fine horses and cattle is a business involving much capital, the roads are often very fine, as they are in many other portions of the country where there are facilities for getting good material. In a community where the race-horse is highly esteemed, good roads would naturally be regarded as a necessity. The building of a really fine road requires the employment not only of proper material well disposed, but the work of establishing good gradients is in rolling and hilly portions of the country one of considerable labor. To execute this kind of work very indifferent and imperfect machinery has been very generally in use.

The military engineer of the present era finds at his disposal improved guns and other enginery of war, which far eclipse in their design and proportions those of any previous age of the world. The exigencies of warfare are such that popular solicitude for public safety and national prestige does not brook the indifference of public officials in these matters, and large expenditures are viewed as patriotic and necessary when made by the Government upon big guns and iron-clad vessels. The wagon-roads which traverse the country as the arteries of internal trade and communication seem, however, to have been overlooked by those ingenious minds which have found a rich field for the exercise of talent in the invention of new and improved war engines. High-class roads would do very much to improve local trade in very many sections of the United States, and increase communication between sections, and thus elevate the condition of the people. Improved machinery for road-making would reduce the cost and shorten the time occupied in

doing the work, and also make an improvement in the finished road. For example, where a road crosses a steep knoll or a deep ravine, the cutting through the hill and the embankment are both to ordinary workmen tedious and difficult, requiring often weeks of hard labor. Such machinery could be introduced as would expedite grading and filling, and reduce the cost to a minimum.

Short tramways on which cars drawn by cable or dummy engines could transport earth from the cutting to the embankment, and steam excavators could be made to supplant hand labor. A complete equipment would require considerable outlay, and should be under the direction of men of experience and skill. At the present time the work of constructing roads and keeping them in repair is in most counties under the charge of supervisors who are elected by the popular vote. Their authority being limited and local only, they have not at their disposal a very large amount of funds at one time. The work done by them is very insignificant, never involving at any one time much expenditure, yet in the aggregate for a term of years the total outlay is large, much larger perhaps than is justified by the work accomplished. Popular feeling has been in some districts aroused against the supervisors, and they have been denounced as politicians who squander the public funds with meretricious cupidity. Method, however, has so much to do with results, that it is very uncertain whether any just blame can be attached to the conduct of these officials. There is no doubt, indeed, that in many districts excellent and efficient work has been accomplished by them with the small means at their disposal, but there is no doubt that in a term of years the cost of wagon roads is much larger than is necessary, and the class of roads maintained is for the most part below the popular ideal under this system. If the great number of tax-payers interested in the wagon roads of the country be considered it would seem that here is an interest which should demand enterprise. The farmer of the present day is indebted to the skill of the carriage and wagon-maker for his vehicles; to the manufacturer of agricultural implements for his tools, and there is no reasonable objection to his being indebted to the professional road-making company for his well-constructed wagon roads. Imagination easily transports the reader onward at this juncture and he awakens about the year A. D. 1900. Almost the first man he meets perhaps is a resident of the State Capital and well known for individual enterprise and influence. In answer to inquiries he replies:

"I am now president of the Capital City Wagon-Road Construction Company, and yonder (pointing with a proud wave of the hand to a large building opposite) is our establishment. Come over and let me show you through. The first story is a large room extending the full length of the building, paved with brick, in which you see a multiplicity of tools adapted to road-making. All these and many more are the tools of our trade. We employ a certain number of skilled workmen. You see that pile of tools, yonder? We send the men out equipped with wagons and tents; they camp on the road and move along as the work is completed, getting supplies from the nearest town. This is our arsenal where we stow the machines. Come up-stairs, where are our vice-president, the engineer and the treasurer and secretary. Our capital is $1,000,000. We have ample means, a full stock of implements, and aim to do the best of work at a minimum cost per mile. We are now using many improvements in machinery which reduce labor and improve the roads. We have aimed to construct first-class roads and have laid out many wide avenues which extend into the country, radiating from the city. This past year we have been building four roads in this county, connecting small towns. They are six rods wide and have a central line of rails for electric cars; on both sides of these avenues the land is laid out in building lots 100 feet front by 200 feet deep, giving an area of half an acre. These lots are being bought by people from town, who are seeking the healthy air of the country, and making pleasant homes, within easy access of the city. Back of them they have the open farm lands, and in front the avenue with electric railway, telephone and electric-light wires.

"Along these roads there is a constant stream of travel. The Tradesmen's Building Association have bought within the past year 200 lots on one of these avenues on which they are erecting neat houses for workmen and mechanics. Thus you see population is being scattered out into the county, and the centres of trade and business relieved of their surplus. The real advantage resulting from this is that it leaves more room for business establishments near the great centres of trade, and takes out of the bustle and crowd of the city many of those who are not immediately engaged in trade, leaving elbow-room for those who are. The result to the whole population has been highly beneficial. It has brought into use a very large amount of real estate not before considered valuable, and prices of building-lots are nearer their true value. A man's residence does not produce anything and should not be held

at too high figures. Our company have within the past eight years constructed roads in many different counties in the State. As we are located at the capital we aim to be a model company in everything. In making our contracts we are careful to have good surveys and maps and specifications which are made by our own engineer. Careful estimates are made beforehand, and when the work on the ground is begun it goes forward without unnecessary delay, and is done as efficiently and thoroughly as possible. Our men are under the direction of foremen and assistants who understand every detail of the requirements and specifications. The labor is greatly reduced in amount and cost by ingenious machines, on some of which we own patents.

"Since road-building companies came into existence common wagon roads have become first-class avenues of travel; the introduction and use of wide tires on wheels has lessened the wear and tear of the road surface and the solid manner in which we built them gives excellent satisfaction. There are many miles of inferior roads yet in use, but year by year they are being reconstructed, and public favor has been fully accorded us for what we have done.

"In some sections we have laid down on the roads tramways of broad iron rails on which vehicles of all kinds travel with great ease and with very light draught. Branches are carried from the main road right into some farmyards and cars are loaded at the barns. Our success shows that there was a real demand for such companies, and many others have sprung into existence. Their standing is now as well assured as that of manufacturing companies generally. As a branch of industry it is new, but as the field of labor is a real one and its finished product is in demand throughout many portions of the country, it has succeeded. Like other kinds of products there will be some fluctuations in the demand, but we think it has become a branch of industry and will continue to be such."

To return to present considerations, private enterprise is always superior in the lines of production to public work-shops under the direction of officials who owe their selection to political influence. This has been shown in the production of all kinds of work, but especially in ship-building and in all kinds of weapons of warfare. The discipline of the army and navy produces order and system, but does not encourage enterprise or foster ingenuity. The officers of these two branches of the public service may be expected to show skill, courage, and patriotic devotion to their individual

trusts, but not ingenuity. The tools of their profession are furnished to them ready-made like their uniforms and swords. So the wagon-road makers might become tradesmen and be so classified.

The rapid introduction of electricity as a motive power has accomplished results which have far outrode all expectation. Its work might be extended in connection with improved road-making. Outside the net-work of railways which intersect the country in every direction, the horse will hold his own as a necessity for private vehicles and many ordinary uses, whatever else may happen. But with electric tramways on country roads near towns, the work of the horse could be done much better in the drawing of heavy loads, while a means of cheap travel would be afforded.

The bicycle at present is very largely used by young persons, and seems likely to continue popular. It requires smooth roads with level grades, and its introduction has very largely increased the volume of travel. Its influence cannot fail to be helpful in the work of road improvement. Private vehicles have been much improved of late years in style and finish, and the number manufactured and sold has been very large. No other method of travelling perhaps affords so much real pleasure as the family carriage, and thousands of families enjoy the luxury of owning and using such a vehicle, which they keep in constant motion traversing the roads within easy reach of the family domicile. Its uses are manifold, and they would become still more so with an improved class of roads, and this consideration will also encourage improvements.

There are many districts where vast areas of land are but poorly cultivated, where indifferent methods of farming prevail and the land is neglected. A complaint that farming does not bring sufficient profit to justify working is common with some large land-owners. In such districts the roads are very poor. Within the last decade a new impulse seems to have been given to horticulture, and increased attention has been paid to agriculture, as a result of which improved methods are rapidly reviving many districts. Fine fruit and grain cannot be hauled over rough roads, and the thorough-going farmer is never likely to be satisfied with imperfect highways. With so many considerations in their favor, therefore, there is hope for better things in road-making, even if the era of large road-making companies should be a long time coming.

A SOLUTION OF THE BLOCK SIGNAL PROBLEM.

By H. Ward Leonard, E. E.

THE attention of the public has been forcibly attracted of late to the importance of efficient automatic block signals by the recent terrible accident in the heart of New York City. Either the failure of the signal or the failure of the engineer of the following train to observe the signal was the cause of this, as has been the case in many other similar accidents. The purpose of this article is to call attention in a cursory manner to the state of the signalling art, and to indicate, if possible, the lines it will be necessary to follow in order to make a thoroughly reliable and practicable block system for railways.

Mr. James F. Hobart has thus happily described the primitive signals which led up to the systems now in vogue : "The need of railroad signals was first felt at the termini of busy railroads in large cities, where the running of many suburban trains so crowded the tracks that great danger of rear collisions was developed. The difficulty was overcome by locating a flagman at a proper distance from the terminal station to stop trains that arrived when the inward track was occupied. Economy soon led to fastening the flag to a telegraph pole by means of a hinge. A cord carried to the station enabled the signal to be raised and lowered from that point, and thus the signal system was established.

"When the cord became worn out, it was replaced by a wire. The flag in time was used-up, and the stick which supported it was replaced by a strip of board painted red. A counter-balance was arranged to make the strip of board assume a horizontal 'danger' position when not held otherwise by the wire or cord. This crude apparatus was the germ of the out-door 'semaphore' signal, and hundreds of them of equally rude construction are in use at the present day.

"The simple signal thus devised protected the train that was in the station at the time, but it offered no protection to the train that was stopped, to protect it against an incoming train. To do this, another signal was set up at a distance of 2000 to 3000 feet beyond the first signal. The new construction was painted green

and called a 'distant signal.' The name and color belong to it to this day. Its office was and is to warn in-coming trains that there might be a train stopped on the track at the red signal. The engineer, upon finding the distant cautionary signal set against him, must reduce the speed of his train and proceed carefully at a rate of speed that would enable the train to be stopped at any instant necessary. This principle of the 'home and distant', or 'cautionary and danger signals,' has been elaborated and applied in the best signal systems in use, both automatic and manual."

There are two general classes of block signals. The first class, the "Simple Block," is in use generally in England, and is well known in this country owing to its use on the Pennsylvania Railroad. For this system a telegraph operator is placed upon each "block" and the signals are set by hand. While this system is capable of being developed to a high stage of perfection it can be done only at very great operating expense. It has been estimated by the best authorities that its cost of operation per block is about $1500 per year. The great expense in establishing and maintaining it, together with the fallibility of operator and inspectors, renders it impracticable except in rare instances.

The second class of block signals is that known as the "Automatic Block," of which there are at least three forms in general use in this country. Two of these use what is known as a track circuit; that is, the rails form a portion of an electric circuit, and the current, which is supplied by batteries placed along the track, holds the signal at Safety until a metallic connection is made between the rails, as for instance, by a car, or train of cars, under which circumstances the current normally passing through the signal is shunted through the axles of the train and the signal goes to Danger.

In one of the systems the electric current is used to release a clock movement which actuates the signal. This clock movement is periodically wound up. The cost of its maintenance is estimated at about $90 per year per signal. The second system makes use of the electric current to actuate a valve which controls the admission of compressed air, and which is the motive power used to set the signal. The cost of operating this system is estimated at $135 per year per signal. The third system does not use the "track circuit," but has an independent wire circuit. The signal is operated directly by the battery current. The cost of maintenance is estimated to be about $65 per year per signal.

In all three of these automatic systems there is a lack of that

simple, direct, powerful, reliable action which should characterize an automatic signal. The batteries which they all use are themselves a fruitful and serious cause of annoyance, if not failure. The electric contacts and relays, and the electro-magnets and signal mechanism are frequent causes of failure and necessitate constant and rigorous inspection.

A careful study of the whole subject, with the help of some recent publications too lengthy to be condensed within the limits of a magazine article,—including a series of articles in the *Railway Gazette* compiled in a volume entitled "American Practice in Block Signalling," and a paper read by G. H. Paine before the New York Railway Club on April 16, 1891—leads to the following specification indicating the desirable features of an automatic block system :

1. There should be signals both on the train and along the track.

2. The signals on the train should give a continuous and positive indication to the engineer.

3. The signals both on the train and along the track should be actuated from a source of energy constantly under the observation and control of the locomotive engineer.

4. The signals should be distinctive both by form and color, and should be audible under certain instances when desired.

5. Any two trains on the same block should each give a danger signal to the other.

6. The power for actuating the signals should be positive, strong enough to operate any desired signal, and should not depreciate and require renewal, as in the case of batteries.

7. The operation of the signal should not depend upon the movements of any mechanism beyond the observation and control of the locomotive engineer while at his post.

8. Any train should have to disregard more than one danger signal before being *able* to reach a preceding train.

9. Any locomotive engineer should be able to communicate with any station or any other train in the same block.

10. There should be a signal constantly before the engineer and in the locomotive cab whose indication will always be "danger" unless *all* his signals are working perfectly.

11. The form and color of the signal should change from "safety" to "danger" under the observation of the engineer as the train passes the signal.

12. The absence of any signal should indicate danger, but there should be a positive danger signal which would only and always give positive and continuous indications to both engineers when two locomotives are in the same block.

13. In case of failure of the train or track signals at any point, means should be provided whereby signals could be instantly sent to a following train.

14. A misplaced switch should set danger signals on any train in that block and also along the track in that block.

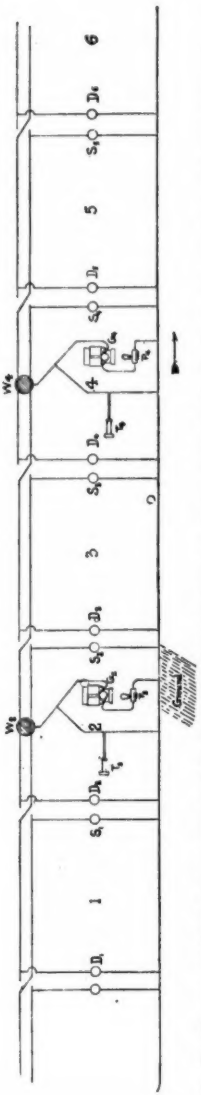
15. The signals should be the same by day or night, and any light at the signal should always indicate the presence of a locomotive in that block.

16. Any person should always be able to signal danger to approaching or receding trains in that block while it is out of sight and hearing and without any light or special apparatus.

About three years ago the writer suggested a block system, which, it is believed, would comply with the above specification, and with the hope that it may lead to improvements in practice, the following description of it is offered:

Divide the line of the railway into blocks of, say, one mile long. Make each block overlap the next one half way. Stretch a bare wire parallel to the track and continuous along each block. Thus a wire one mile long will start from the beginning of each block and another parallel to the first will start at the centre of the first. There will thus always be two parallel conductors along the track and a conductor will end and a new one begin at each half mile. The forward end of each mile length of conductor will be connected by a wire leading to a green incandescent lamp, and the other terminal of the lamp will connect with the ground. Similarly the rear end of each conductor will connect with a red incandescent lamp.

Upon each locomotive will be placed a generator of electricity of about 100 volts; that is, about the pressure of the incandescent lamps. This generator can be a battery or, preferably, a small dynamo, driven by a small engine which is operated by steam from the locomotive boiler. One pole of this generator is grounded by making contact with the metal work of the locomotive. A conductor leading from the other pole of the generator passes through an ampere meter for indicating the current being generated, and thence on through a low-resistance series incandescent lamp, which, when supplied with the current of four of the track signal *lamps*,



D_1, D_2, D_3, etc., are the red lamps connected to rear ends of the sections 1, 2, 3, etc., respectively. S_1, S_2, S_3, etc., are the green lamps connected to the forward ends of the sections 1, 2, 3, etc., respectively. G_2 and G_4 are the generators on trains in sections 2 and 4 respectively. P_2 and P_4 are the Pilot lamps in series with the generators and placed in the locomotive cabs. T_2 and T_4 are the telephones. W_2 and W_4 are the trolley wheels making connection between the signal conductors and the generators.

Under the conditions shown in the diagram the train in section 2 will light its Pilot Lamp P_2, the forward green lamps S_2 and S_3 and the rear red lamps D_2 and D_3. The preceding train in section 4 will light its Pilot Lamp P_4 and the forward green lamps S_4 and S_5 and the rear red lamps D_4 and D_3.

will operate at a moderate incandescence. After passing through the series lamp, which we may call the pilot lamp, the current passes to a trolley carrying a large wheel made after the style of a bicycle wheel, and this wheel makes rolling contact by a concave rim upon the two parallel conductors stretched along the track.

Now it will be evident that if the generator be operated the electric current will pass through the pilot lamp and up the trolley to the two conductors; thence it will divide equally between the four lamps connected to these two conductors, passing through two green lamps ahead of the trolley, and through two red lamps to the rear of the trolley, the green lamps as well as the red, being half a mile apart.

As the train moves forward the trolley will finally roll off the conductor of the block it is leaving, and both the red and green lamp of that block will be extinguished. At the same time the trolley will roll on to a new block and the red lamp at the rear end of this block will light up just as the locomotive reaches it and will then pass to the rear. At the same time the green lamp at the forward end of this new block will light up at a distance of one mile off.

It will be seen that a following train would have to pass the two red lamps of the preceding train before a collision could take place; also that whenever two trains would

get within a mile of each other the generators would be acting in concert to divide the combined loads of the two, and whatever the current of each had been previously, it would immediately become different, the generator having the higher pressure taking the larger portion of the combined load. Thus the pilot lamp of one locomotive would flash up and its ampere meter would indicate a greater current than usual, and this by a contact on the ampere meter-needle would cause an alarm-bell to ring in the cab. Similarly the pilot lamp of the other locomotive would be reduced in candle power, the ampere meter would show a reduced current and the alarm would ring on the lower contact. At the same time the locomotive engineer of the following train would see before him the red lamps of the preceding train in addition to his own green lamps, and a rear guard on the preceding train would see in addition to the red lamps of his own train the green lamps of the following train. On each locomotive a line containing a high resistance is led from the trolley and around the generator to ground, and this circuit in shunt to the generator contains a telephone. It will thus be possible for either locomotive engineer to talk to another engineer preceding or following in the same block, and regardless of whether either or both are in motion. If telephones in the various stations be similarly connected from the signal conductors, communication can be carried on between the station-master and passing trains.

If it be desirable to stop an approaching train it is only necessary to interrupt one of the signal conductors or connect the two together, or ground either. If the conductor be broken or disconnected, the engineer when a mile away finds his pilot-lamp dim and his alarm ringing because the current from his generator is reduced by one-quarter.

If a signal-conductor be grounded, as soon as the trolley makes contact with that conductor the generator is short-circuited, and its pilot-lamp first flashes up brightly and the bell rings and then the current runs down rapidly and the bell rings by the lower contact. If the two conductors be crossed, the load of two more signal lamps is added to the normal load of the generator, and this increase of 50 per cent. in the current makes the pilot-lamp flash up and the alarm-bell ring at the same time the engineer sees the red lamp of the abnormally supplied block burning before him.

If a train breaks down its generator, it keeps its trolley on the wires as before, and as soon as it gets into a block with another train, its pilot-lamp lights and the alarm rings.

If the other train be preceding, its two rear red lamps also signal danger to the following disabled train, and the engineer of the preceding train also receives a danger signal by its alarm-bell and the increased current of its pilot-lamp. If the disabled train is followed by another into the same block, an abnormal red signal is set between the two trains, green lamps light up in advance of the disabled train and the pilot-lamp and alarm on both the trains indicate danger.

If two trains near each other both had their apparatus broken down, both would, of course, be moving very cautiously and endeavoring to ring the telephone call of any other train which might come into the same block with them.

A misplaced switch would make a contact which would light a red lamp in front of an approaching train.

Now as regards the signals along the track, the incandescent lamps should be arranged in a proper signal-box, and the green lamp should show a vertical band of green lights whereas the red lamp should show a horizontal band of red light, thus giving a signal defined by both form and color.

Two possible objections which may be raised against this method of signalling are :

First. The presence of a car on a track without any accompanying attendant would not give a danger signal as it would with a track-circuit system. This, however, is a rather remote contingency, and in any event could not lead to an accident with much loss of life. The unreliability of the track circuit is so great in other ways, as to make this slight defect almost negligible by comparison.

Second. The action of sleet might interfere with the action of the signal by preventing electrical contact between the trolley and wire. This trouble would be rare, in any event, and it is not likely to occur, as the heating effect of the strong current on the wire would tend to eliminate this trouble, just as it does with electric railway systems. If, however, it became necessary to provide against this, it could be done by placing the conductors beneath a semi-circular structure, such as a tube sawed longitudinally and concave downward.

It will be evident by examining the specification as to the requirements of a safe system that this plan avoids the defects of the present system.

The next consideration is as to its first cost and maintenance,

and it will be evident that the advantages on these points are conspicuously in its favor, for the simplicity of the signals and the cheapness of the small bare conductor make its first cost less than that of any existing system. The cost of operating will be almost *nil*, as there will be almost no need of inspecting signals, having no batteries, electromagnets, relays, weights, clockwork, compressed air, oil-lamps, or the various other possible causes of failure of the existing systems.

It will be evident that by connecting along the signal conductors white incandescent lamps, and increasing the size of the generator, the track can be perfectly and uniformly lighted both in advance of and behind the train as it moves forward ; and that also all crossings and stations can be lighted while a train is within a mile of them. Two-and-a-half horse-power would in this way be all that would be necessary to keep a track illuminated by 16 candle-power lamp every 200 feet, and for a space of not less than half a mile in both directions from a moving train.

Trains having an electric plant for illumination of the cars require a plant of about fifteen horse-power, so that the additional power required in such a case would be hardly worth mentioning, and no special generator beyond that for train lighting would be needed.

THE NEW ART, DECORATIVE ELECTRICITY.

By N. G. Wall.

CONSTANTLY confronting the brilliant material results of scientific investigation, we are apt to pass them by with indifference, unless attracted to them by pecuniary interest or through curiosity aroused by some special incident. If some guide acquainted with all the modern applications of scientific discovery could journey with us, for a single day, over the daily path to which we are accustomed in the pursuance of our ordinary avocations, calling our attention to and explaining the scientific and mechanical wonders we have so often passed without even a suspicion that there was anything wonderful about them, most of us would return to our homes at close of day much wiser than when we left them in the morning.

Nothing among all these marvellous new things of which the preceding generation did not even dream, has wrought more radical changes in our manner of living, working and transacting business, than the applications of electricity which are daily entering more and more into the necessities, conveniences, and luxuries of life.

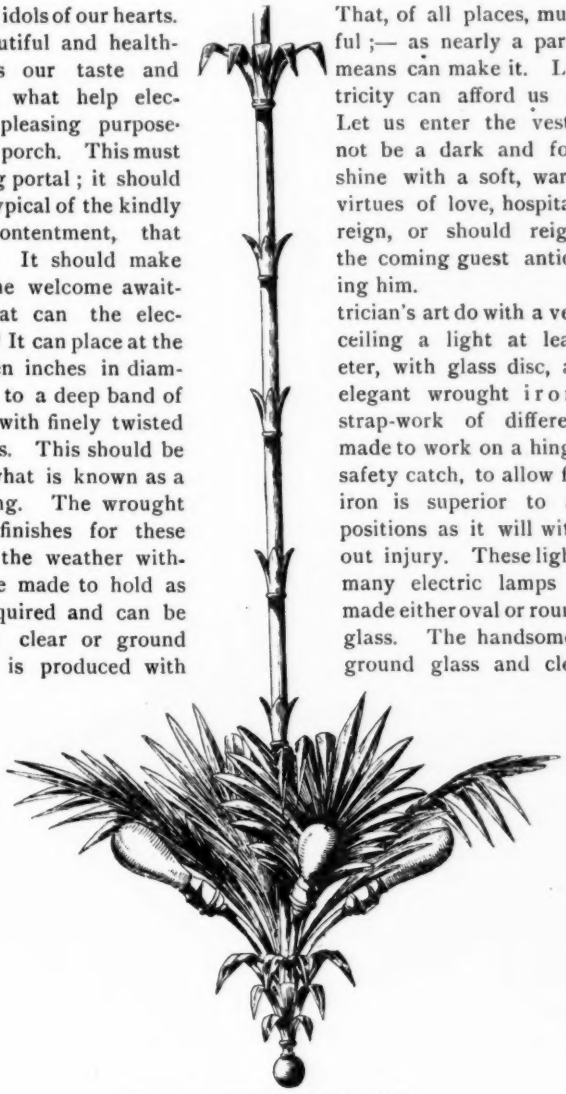
RENAISSANCE BRACKET.

The purpose of this article is to direct attention to the decorative possibilities of the new art of electric lighting,—as yet only faintly discerned by most people,—and the many artistic ways in which it may be made to assist in the beautification of homes and public buildings ; as hotels, churches, theatres and other halls of assembly.

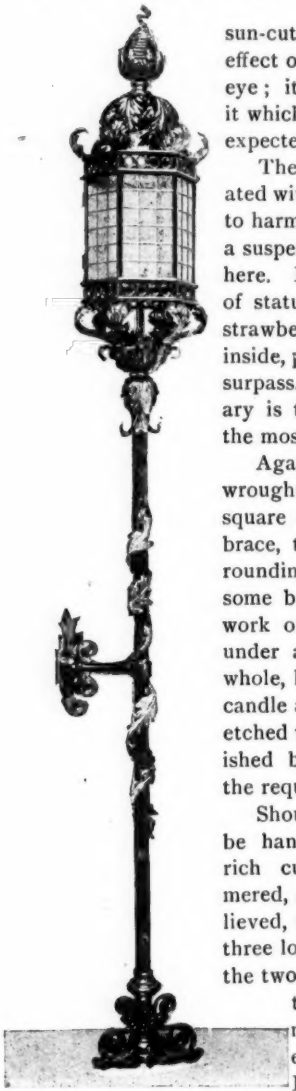
Naturally, in the consideration of this subject, the first thought is of home, that temple of retirement in which are enshrined the

dearest idols of our hearts. That, of all places, must be beautiful and healthful ;— as nearly a paradise as our taste and means can make it. Let us see what help electricity can afford us in this pleasing purpose. Let us enter the vestibule or porch. This must not be a dark and forbidding portal ; it should shine with a soft, warm light typical of the kindly virtues of love, hospitality, contentment, that reign, or should reign, within. It should make the coming guest anticipate the welcome awaiting him.

What can the electrician's art do with a vestibule ? It can place at the ceiling a light at least fourteen inches in diameter, with glass disc, attached to a deep band of elegant wrought iron-work of different designs. This should be made to work on a hinge, with what is known as a safety catch, to allow for cleaning. The wrought iron is superior to all other finishes for these positions as it will without injury. These lights stand the weather without can be made to hold as many electric lamps as are required and can be made either oval or round, with clear or ground glass. The handsomest effect is produced with ground glass and clear



ORIENTAL HAMMERED WORK ELECTROLIER.



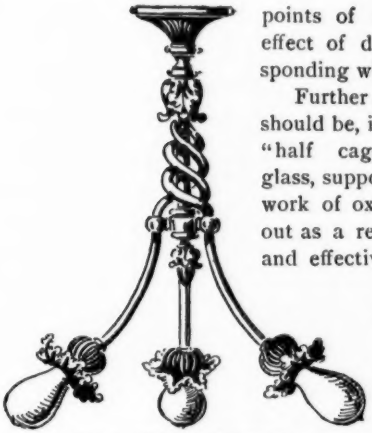
ITALIAN FALLOT.

sun-cutting at the bottom. When lighted, the effect of this light is more than pleasing to the eye; it produces the impression on approach to it which can only be interpreted by "You are expected; come in; you will be welcome."

The main or entrance hall should be illuminated with very careful and practical taste, so as to harmonize with the other decorations. Either a suspended fixture, or newel light may be used here. If a newel is preferred, a beautiful piece of statuary with uplifted arm, holding a large strawberry cut globe, with at least three lights inside, produces a richness which it is difficult to surpass. The most artistic finish for such statuary is the real bronze, which will blend with the most delicate of decorations.

Again, an artistic newel may be of real wrought iron or brass, with gracefully arranged square rods, twisted in the centre, to act as a brace, the top and bottom terminating with rounding lines; and just above and below handsome bands of either beautifully beaten iron-work or castings of brass, and breaking from under a large globe, which surmounts the whole, having a curved arm with an electric candle and bobeche of soft ground and finely etched work; when in brass, the antique polished brass or oxidized copper finishes have the required feeling.

Should the light be suspended, nothing can be handsomer than a sectional globe with a rich cutting and mostly covered with hammered, antique, polished brass oak leaves, relieved, with a little oxidized silver, and with three long rods supporting the band which holds the two parts of the globe; twining up these, the branches with smaller leaves and ornamental pieces, represent the bud and end in a neat design of cast canopy. From the bottom globe can be arranged a silk cord and tassel-work knotted at



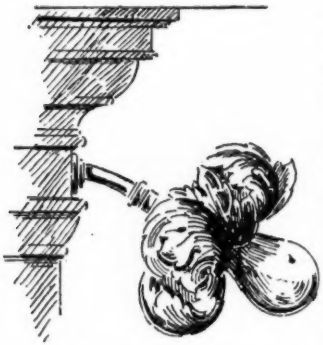
RENAISSANCE CEILING FIXTURE.

points of equal distance to give the effect of drapery of a rich hue corresponding with the colors on the walls.

Further along in the broad hall, there should be, in place of bracket lights, the "half cage," with soft, ground, bent glass, supported by strap-work with cast work of oxidized silver worked in and out as a relief. These produce the soft and effective light necessary to give a feeling of quietness, yet not having the appearance of darkness, but adding richness to the surroundings.

The drawing-room should be so arranged as to have a little or a great deal of light, just as the occasion demands. This is very simply done by using what is termed a switch-board, which can be placed to suit convenience. A very handsome effect for this room is produced by suspending from the centre of the ceiling a graceful electrolier comprising from five to ten lights, according to the size and height of the room, finished in mat gold gilt, with or without rich but finely-cut shade and frosted lamps; if without the shades, a fine cast ornamental piece of metal, representing leaves bearing on each other, may be used. On the four corners of the ceiling, at a suitable distance, the ceiling lights, fourteen inches in diameter, with artistically arranged art glass, having deep bands of mat gold gilt work, giving the effect of a fringe, produce a very fine effect. On the side walls should be placed a few brackets, each with three to five lights, using the electric candle, which should be frosted, and using the cut bobeche to match the electric shade,—if the latter be employed,—or the etched bobeche, with frosted ground-work, which has a very delicate relief. Of course, all these smaller trimmings are a matter of taste; in many cases colors can be used. In case of using this class of work, after the style of Louis XVI., (which should be not only generally light in construction, but of a light,

RENAISSANCE CEILING FIXTURE.



HAMMERED WORK BRACKET.

cheerful finish and delicate in design) the decorations of the room should be white and gold, with panelling of blended colors.

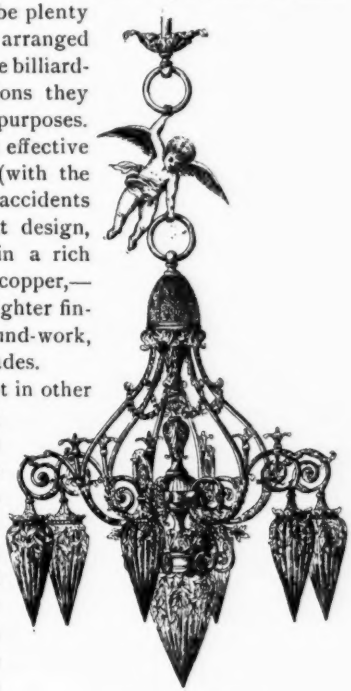
Again, in drawing-rooms where the decorations are deeper, and which demand something heavier in construction, the Renaissance may be used extensively in many ways, and, with almost any design of architecture of the present date, can be arranged to suit many tastes. In this we have a class of work which demands, for the true complement of the fixtures, the use of electric shades. No matter what their position may be, in each design the eye can detect the style and shape of pattern most suitable for the fixture and its surroundings either in the hall, drawing-room, library, dining-room or sleeping apartments.

In a house of Colonial style, with its long porch, broad halls and stairway, landings and peculiar arrangement of rooms, a variety of styles can be introduced with good results. It taxes the artist, in a great many cases, to get the proper effect in his lighting, on account of the very low ceilings. A beautiful effect is gained, after leaving the porch, by the employment of a lantern shaped fixture having protruding arms with stalactites hanging from each corner, and the cage, paneled in four parts of different, soft-colored glass almost covered with tastefully arranged lines of beaten iron work of a design corresponding with the lines of outside decorations. The reception hall should be lighted with an electrolier having a suitable number of lights, to correspond with the same design, suspended from the third floor, and having the appearance of being at the second. The hallway, as well as the stairs, being much broader at this point, a large number of lights is demanded to produce the desired

RENAISSANCE STANDARD.

effect, assisted, on the second floor, by a few brackets to match, placed just over the wainscoting in such a way as to obtain that softness we need when lounging on cushioned seats for rest and thought.

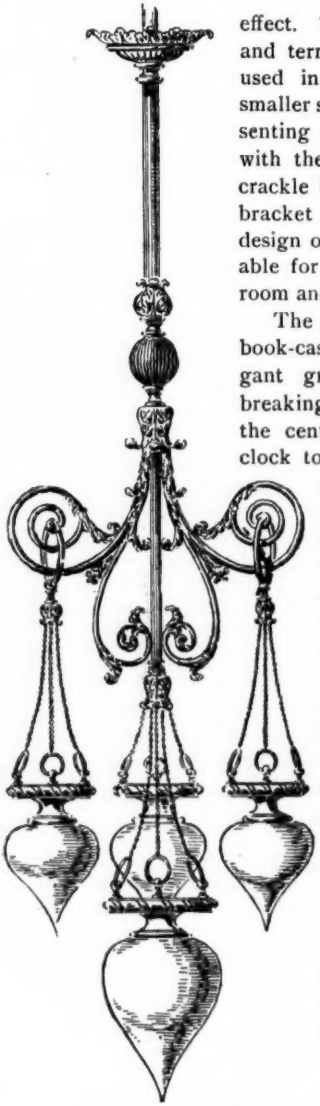
The lights of the stairway should be so arranged, that no matter which way one looks there will be plenty of light. This floor is generally arranged to have the guest room adjoin the billiard-room; so that on state occasions they may both be used for dancing purposes. In the guest chamber the most effective light is a number of brackets (with the lights turned up to avoid any accidents during the dancing) of a neat design, yet not gaudy, and finished in a rich antique, very dark, polished copper,—with here and there a little brighter finish breaking from the dark ground-work,—and trimmed with etched shades.



LOUIS XVI. ELECTROLIER.

The billiard-room, while not in other use than for the fascinating manipulation of the spheres, is provided, according to the size of the table, with a fixture constructed of four ten-inch discs, supported by arms with cast bands at the top so arranged that they may be removed by any one, and controlled by a switch at what is termed the bottom knob, to control the four lights. Almost any finish will answer in this case; but the bright polished brass, with a little black, has, with the discs, a very pleasing and not tiresome effect.

The music-room, with arched doorway, should have, suspended from the centre and each side, clusters of lamps, set in beautifully hammered copper ornamented with highly polished leaves of palm or fern; and from the centre of the ceiling the electrolier, ornamented with much larger leaves leaning forward with lights just under them—the leaves serving as reflectors—produces a charming



COLONIAL ELECTROLIER.

effect. This style of work is considered and termed "Old English"; and it is used in many other rooms, on a much smaller scale, with the side lights representing the double fan; the fishing rod with the light as a hook; the hanging, crackle bowl, suspended on chains as the bracket for the well; and almost every design of a light and pleasing effect, suitable for the lounging-room, the dressing-room and chamber.

The library, with the long, worked-in book-case, should have, at each end, elegant grill-work with electric candles breaking from it as if a flower; and, on the centre, the old work wrought-iron clock to match; on either side, the candelabra should be placed and so arranged by switches as to light separately from the grills. From the ceiling should be suspended an electrolier of three arms and centre light, with finely engraved stalactite of smaller size than the centre, which, representing a ball with engraving to match, should be finished in a very soft velvet-polished copper, relieved with polished brass pieces.

The oriental-room may be decorated in a variety of colors, with arched rail so arranged as to receive the small, old copper lantern, with ruby glass; and, from the ceiling, the octagon lantern, with antique arms at the corners and colored glass centre, having Japanese designs cut through the sheet metal, and finished in almost a brownish black relieved with

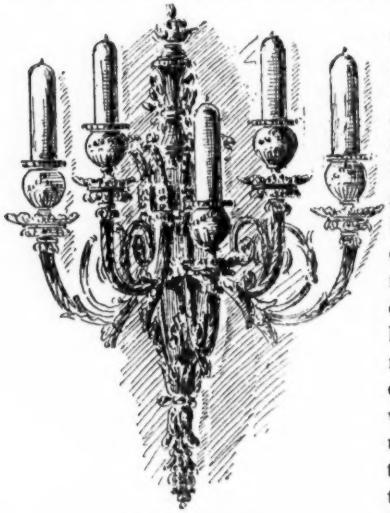
gold at all the raised points, completes the electrical decoration.

For the large ball-room, when the floral display is elaborate, a very pretty idea is to have breaking from the decorations in the clusters, a few, small, colored lamps, to give life to the flowers and cast the colors in a blending form ; still retaining, however, the power for lighting. In the garden, where the evening may be spent by the large rockery with a fountain on top, the lights may be brought out in the same way, and give a sun effect.

The conservatory may be lighted in many ways to give a very desirable and beautiful appearance ; one method being a fixture suspended and representing an umbrella with the lights as the ribs; and painted white inside, by which it takes the place of a reflector ; if a novelty is required, a very small stream of water can be arranged to drip and represent rain. In the corners can be used the owl holding a branch of a tree and hanging lights, very small colored lamps forming the eyes.

The dining-room should be so lighted as to use a large, stationary dome centre-fixture with at least three to sixteen candle-power lamps underneath ; and it should have four clusters of fine lamps each represented as standing in husks. There should be a separate switch for each cluster ; and the dome should be covered with a richly worked cuirass that will show the delicate tint of the dome, and which should have a dark steel finish or be finished in oxidized silver tipped with a brighter relief. On the side walls brackets can be placed to match ; and as a matter of taste the electric candle can be used, which gives a very beautiful relief and carries out the features of the centre or main light. In this way, on ordinary occasions, it would only be necessary to use the centre or dome light.

Now let us enter a hotel, with its grand entrances and superb parlors, and see what we can do. The main entrance can be arranged so effectively and in so many ways that space will not permit a description of them. For the entrance, with its onyx partition, with reception chairs and lounges, depending for its light upon the adjoining room (which may be a café or restaurant), what could be handsomer than large, cut-glass globes, supported by a large band built in the wall as if part of it, and finished to match the iron or brass work above it—thus lighting two sides at once? On the opposite sides, surmounting this onyx-work a beautiful piece of grill-work should be placed, with the electric clock in the centre having a raised dial and lamp behind, breaking like flowers in



LOUIS XVI. BRACKET.

various places,—the electric lamp almost covered with leaf-work, and tinted in such colors of copper and gold as to have the effect of age. Fallots, which represent the antique lamp which was lifted from the socket and carried to necessary points, may be attached to the ends of the grill-work. The fallot is a fixture with a long rod or handle of at-least seven feet, covered with plush, with twining leaves running upward to a lantern of sixteen inches, with canopied top, and sided with art glass in squares of two inches, giving the fixture an antique finish and a never tiresome light.

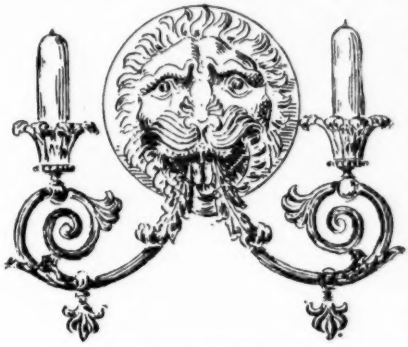
Appropriate for the café is a large, glass, cut globe, with silver bands and canopy, and long chains of small glass beads and prisms; and, as if a coronet to the globe, a ring of glass balls. When lit, the effect is a silvery hue, not bright to the eye, but gentle and pleasing. The buffet bar should be bright in all respects; and to get this, polished copper has the desired effect, not only lighting but casting a golden tinge on all the surroundings. The restaurant, when finished with a large mirror, should have, breaking from the centre, a continuous line of brackets, in clusters of from three to five lights, alternately arranged so as to have one group of the five lights reflect against the opposite one of three, and finished in a very bright gold gilt relief on mat-work. On the column twining lights, arranged at least eight inches above the brackets, add very much to the proper distribution and effective lighting of this most important of all rooms in a hotel.

The drawing-rooms can be arranged to have more than one style of decoration; and in the main rooms a beautiful design would be clusters of at least ten lights suspended from elegantly curved bracket arms of corresponding feature, supporting from small chain-work the stalactite, ground inside and having a cut bottom and fine etching of a lace pattern; these should be hung

at the four corners, and not from the centre of the ceiling. For the "Empire Room," if such be used, the fixtures should be so constructed as to show its long-drawn lines with reeded tube-arms supporting a tall shade ornamented with etching or cut work of garlanded flowers, and finished in a dark green with a light relief of green and gold gilt; and on either side should be arranged a bracket of three lights having a corresponding design. The effect of this design is simply grand.

The fixture for the rotunda, which is much heavier in general construction, should in all cases support, over what is termed the body of the fixture, a large globe or figure holding a light, standing between the rods from which the arms break, and finished in a very rich mat gold gilt with all lights directed upward.

Generally, the private or ladies' entrance must be not only delicate but tasteful in its style of decoration; and it should have, on each side of the pilasters, brackets, arrayed from goose-necks and representing flowers hanging in clusters; as the white lily, hanging not directly down, but curving as if determined to stand in a natural position; these should be guarded by other brackets of the dragon order, shooting lights from their open mouths, finished in Damascus steel with armors in gold gilt, the lilies being of a delicate antique copper with oxidized silver trimmings and copper-tinted leaves. The reading-room must be so lighted as not to have a glare, and not to tire the eye; this can be accomplished by using extremely large leaf-work with the leaves leaning against each other and covering the ground glass lamp which will rest on the leaf below, thus reflecting from the highly polished copper a soft yet pleasing light with which even the most fastidious can find no fault. Here and there may be placed an electric bracket of the same order,—say two or three lights—hung high enough to cast the light on the reader.

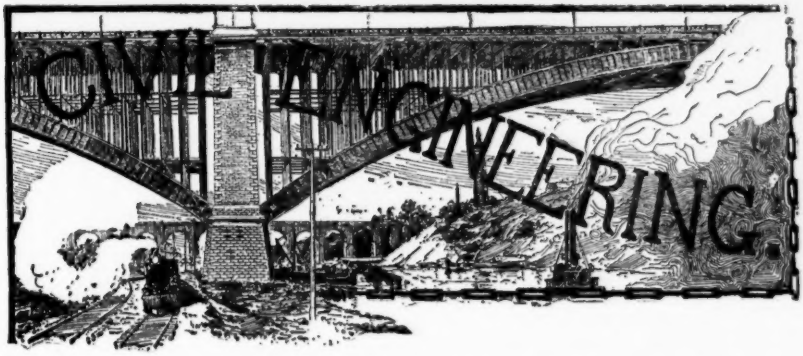


EMPIRE BRACKET.

The arrangement of hotels varies so widely, that any description of the different designs applicable to minor rooms

is obviously impracticable in an article of this kind. A glimpse at the possibilities of a new art which goes hand in hand with the sister arts of architecture, sculpture and painting, is all that was contemplated. Taste, skill, study, and above all, artistic feeling, are essential to success. With these qualifications, there is no limit to the scope of decorative electricity.

RENAISSANCE CEILING LIGHT.



THE Contamination of Croton Water in New York City, as determined by the chemists of the Board of Health, appears to arise from causes beyond the control of these useful officials. The watershed lies outside of the territory under control of the municipality; and unless the State Board of Health takes the matter vigorously in hand, the pollution of the water is likely to continue and the health of the city will be endangered. Although the prevention of the contamination of city water supplies in the State of New York has been made the subject of legislation, and the State Board of Health is thereby empowered to make rules for preventing the discharge of filth into streams which feed such supplies, the law, as regards its imposition of penalties and its methods of reaching offenders, is so defective that the city may suffer a long time before a remedy can be applied; and with the influence that politics exerts upon every department of the State government, there is little hope that the action of the State Board can be invoked to secure permanent relief. In some way the authority to act with promptness and vigor ought to be invested in the Board of Health of the city. The purchase and continued ownership of the entire watershed by the city has been suggested; and this, though at first sight it may appear preposterous, will not be found, upon due consideration, so impracticable a scheme as to merit immediate dismissal. There is in the watershed, in round numbers, 231,680 acres. The average value of this land, we should think, cannot be more than $60 per acre, taking into account the fact that a portion of it is not valuable for agriculture. But averaging the price at $100 per acre its purchase could be effected for 23,168,000 dollars. The property could then be again sold or leased under restrictions the violation of which would invalidate title or lease, as the case may be; and an inexpensive system of patrol would, under such conditions, effectually put a stop to water pollution.

The First Bridge over the Mississippi River, according to Mr. F. W. Cappelen, member of the Engineers' Club of Minneapolis, is asserted to have been the suspension bridge erected at Minneapolis in 1854. This bridge having insufficient capacity, was superseded in 1875 by a new suspension bridge built under the direction of Mr. Thomas M. Griffith of Lewiston, N. Y. The latter having been found from the first difficult to keep in repair, and finally being condemned as unsafe, was ordered to be taken down. The process of taking down involved some very considerable difficulties which are pleasantly described by Mr. Cappelen in a recent very interesting paper read at a meeting of the club named above, and printed in the *Journal of the Association* of Engineering Societies for August. The chief difficulty seems to have been met in taking down the cables. Mr. Cappelen's scheme was to put up a steam-engine and pull out single wires winding them upon a drum. The wires being about 975 feet long would, when wound, make a coil weighing about 50 lb. This plan was adopted. However, the mistake was made of cutting too many wires at once; and, as many of the wires had been spliced by hooking their bent ends together, these hooks got the wires

entangled; and, to use the precise words of Mr. Cappellen, "in a short time there was a pretty mess. Wires everywhere, single and in bunches, tangled and straight; and in trying to pull out some apparently clear wires matters grew worse." At this stage, as Mr. Cappelen frankly admits, his plan for taking down the cables seemed to be impracticable. However, after considering several substitute schemes, none of them seemed to promise any better; and so the attack was resumed, this time taking care not to have too many loose wires; and with practice and increased experience the cost of taking down was reduced to 20.8 cents per wire for the entire job, as compared with 31 cents per wire very nearly,—the cost of taking down the first cable attacked. The two last cables taken down cost 18.5 cents per wire for the work. Averaging the cost and allowing each wire to have a weight of 50 lb., the cost of removal was 0.416 cents per lb.

Tests of Coil Boilers made by Chief Engineer Charles H. Loring, for the U. S. Navy Department, have, according to the report submitted by Mr. Loring, demonstrated the superiority of Ward's boiler as compared with that of Cowles, the only ones which in response to the invitation of the department were submitted to trial. The superiority of the Ward boiler was not, however, very remarkable in evaporative efficiency, which with the Cowles boiler was 1, as compared with 1.086 for the Ward. Accessibility of parts, facility with which repairs can be made; and its simplicity coupled with interchangeability of parts and less weight, as compared with Cowles boiler, appear to have greatly influenced the report in favor of the Ward boiler. The latter has been adopted for the *Monterey*, designed for coast defense; and four of the boilers aggregating 4500 horse power and costing $60,000, have been placed in that vessel. Engineers will watch with great interest the record of these boilers. If they prove as satisfactory in use as many anticipate, a great advantage in decrease of weight will be gained as compared with the various forms of marine boilers hitherto used.

The Construction of the New Steel Bridge over the Mississippi at Memphis is rapidly progressing. The bridge is noteworthy for several reasons. It is remarkable for the length of its spans which, so far as we know, is exceeded in only two bridges, namely, the great Forth bridge and the Lansdowne bridge at Sukkur in India. It is also remarkable for the depth of its foundations, the extreme depth being 131 feet below water. There are five of these piers resting on caissons from forty to eighty feet in depth. The structure is of a mixed type, being partly cantilever and partly truss. The anchor span on the eastern end is 225.83 feet in length. Next is a span composed of two cantilever arms each 169.38 feet long with an intermediate truss span of 621.06 feet. Next in order is a continuous truss span also 621.06 feet in length. Then follows another span composed of a cantilever arm 169.38 feet long and parallel trusses spanning 451.66 feet, one end supported by a pier and the other by a cantilever, and a deck span at the western terminus of 338.75 feet. The total length is 2597.12 feet. This bridge was commenced in November, 1888. Work is now about to be begun on the long truss span, the first cantilever and the main span having been completed.

The Grand New Cantilever Bridge which spans the Ohio River between Cincinnati and Newport, Ky., thus not only connecting two cities, but two States, has, since our last issue went to press, been completed and opened with imposing ceremonies, comprising processions in which both cities took part, parades, fireworks and a grand banquet. This event took place on the 29th of August. A noticeable feature of the ceremonies, was the advance, respectively, from the Ohio and Kentucky sides of the river, of the Governors of the two States who met at the centre of the bridge and joined hands as symbolizing the united interests of the two States joined by the magnificent structure. The bridge was designed and built by the King Iron and Bridge Company of Cleveland, Ohio. It is owned by a chartered company called the Central Railway and Bridge Company, and

its cost is given as $1,300,000. Its steel towers at the ends of the centre span are each 85 feet above the masonry and 190 feet above the foundations of the piers, of which there are nine containing 12,000 cubic yards of masonry. The *Enquirer*, Cincinnati, gives dimensions and other facts relating to this bridge, from which we extract the following:

"It extends from the southeast corner of Second and Broadway in an easy curve for a considerable distance, 282 feet of which is paved with granite blocks. After the approach proper, a steel viaduct of 150 feet in length, a steel truss of 108 feet, another steel viaduct of 81 feet, and a steel truss of 162 feet are passed, the top of the gigantic pier at the shore of the Ohio River is reached. Here begins the cantilever which consists of two spans of 252 feet each. The central span which crosses the channel is 520 feet in length. After this are two spans of steel trusses 254 feet each, plate girders 55 feet long, 213 linear feet of steel viaduct, a plate girder bridge of 33 feet crossing Eglantine (Second) Street, Newport, and then 333 feet of masonry paved with gray granite to the end at York and Third Streets in the sister city. The total distance from Second and Broadway to the end in Newport is 2916 feet. There are two roadways of 24 feet clear width, with two street-car tracks laid below the bed of the roadway. The sidewalks on either side are seven feet in width."

A New Trunk Railway from Superior, Neb., to Galveston, Tex., is projected, and a company has been organized to carry out the project. According to the *Manufacturers' Record* (Baltimore)—which, by the way, is one of the most industrious and reliable collators of business news published in this country—the company has made contracts with Mr. Thomas A. Butler, a noted New York contractor, to construct that part of its road lying between the Nebraska border and the Red River, including bridging, ties, laying rails, surfacing and ballasting, but not including materials. Robinson & Brickley, of Easton, Missouri, have made a similar contract, to cover all the territory from the Red River to Galveston. The officers of the company are: President, Jacob Newberger, 111 Broadway, N. Y.; vice-president, C. M. Rawlings, Lyons, Kansas; secretary Valdemar Sillo, 330 East 51st Street, New York; chief engineer, Edward Roemer, 177 East 93d Street, New York; treasurer, D. M. Bell, Lyons, Kansas. It is further asserted that the bonds for construction of the road have been negotiated in London, and that the purchase of and the payment for all materials for construction of the road have been completed. The purchase of the rolling stock has also been made, and a partial shipment of the materials to Lyons, Kansas, has already been done. All this indicates great business activity on the part of the projectors of this new road, which the journal above quoted intimates is eventually to be a continuation of the Chicago, Burlington and Quincy system.

An Association of Superintendents of Railroad Bridges and Buildings is to be organized. A call for a convention has been issued, the first meeting to be held in St. Louis on September 25, for the purpose of perfecting the organization, which is to be national in its scope. The movement is said to have originated with Mr. J. O. Travis, superintendent of bridges and buildings of the Iowa Central Railway Company. The objects of the association are the attainment of advanced knowledge relating to construction, maintenance and repairs, and general improvement resulting from systematic interchange of opinions, discussions, reports, investigations, etc. There is no doubt that such an association may be of great benefit to its members, and it is with pleasure that we record its initiation.

The Sewerage System of Cleveland, Ohio, is stated to be a problem that will demand immediate solution, and which, according to the *Press* of that city, will be an engineering work that *must* be done within the next ten years, and one the magnitude of which will dwarf all the previous public works of Cleveland. The Cuyahoga River into which sewage discharges is described by other papers as reeking with filth. A part of the sewage also empties into the lake, and the extension of the water works tunnel several miles further out into the lake has been thereby necessitated. This is also a very large engineering work which is already in

progress. The state of things as described in the *Press* excites wonder that some serious epidemic has not smitten the city. It says:

"The Cuyahoga never was a large stream, and before the city grew up on its banks navigation was restricted to very small boats. The dredge has, however, deepened its channel until the bottom is as low as that of the lake at the mouth. South of the city the river is but a creek, and the supply of water it sends down to the dredged part is very small. As a consequence the current at the mouth is only equal to the little supply of water received from above, and this is hardly perceptible. As the many sewers discharge their contents into this dead arm of the lake the filth is scarcely moved by the sluggish current. When a freshet finally does clean out the river the result is immediately noticeable in water drawn from the crib. Consequently the first necessity is an extension of the water works tunnel beyond the line of polluted water, and the second is some plan either to create a current in the river or intercept the flow of sewage into it."

The Site of the Western Terminus of the Hennepin Canal is to be made the subject of an investigation and a report by a board comprising the following Army Engineers who have been commissioned to perform the service: General O. M. Poe, Chairman; Major Alexander Mackenzie; Captain Marshall.

The New Swedish Smokeless Powder known as *apyrite* has been made the subject of prolonged and thorough tests by Swedish military engineers. Superiority, as compared with other smokeless powders, is claimed for apyrite in the following particulars: It may be heated with safety to a temperature at which other smokeless powders would be dangerous, or which would at least be injurious to their composition; and it does not compact or cake when stored in bulk. In firing, it heats gun-barrels much less than ordinary gunpowder and very much less than nitroglycerine powder. It is very cleanly, and barrels are easily cleaned when allowed to stand uncleaned for a considerable period after its use. It does not detonate by percussion. Apyrite is a shining black powder with prismatic grains. In character it is said to be a species of nitro-cellulose containing a large proportion of nitrogen. It gives high initial velocitics with moderate pressures.

The Refrigerator Scheme of Pension Commissioner Raum, proposed by him for the new cruisers, has been rejected by the U. S. Navy Department. In this scheme the name *refrigerine* was given to the substance the solution of which in water produces cold, and the recovery of which in solid form is effected by evaporation of the solution. The nitrate of ammonia is the substance, or the principal ingredient in the substance, employed under the name above given. The Allen Dense Air Ice Machine is now employed on Government war-vessels, and it has proved safe, convenient and effective. The committee appointed to investigate the alleged merits of refrigerine for marine use, reported as follows:

"First—That there is nothing new in the use of refrigerating mixtures for producing cold, and that nitrate of ammonia has been used for the purpose for over fifty years, but has never heretofore been able to successfully compete with other methods of refrigeration.

"Second—That the system is cumbersome and not adapted to ice-making.

"Third—That the space occupied by the material alone precludes its use for refrigerating purposes on board of naval vessels.

"Fourth—That its cost for refrigerating purposes on board of naval vessels would be nearly double that of the devices now in use.

"The board, therefore, does not recommend that it be adopted for use in the naval service."

The New Explosive, Terrorite, was tested at Fort Hamilton on the 8th September. The test consisted of the explosion of a shell charged with terrorite and buried in a hole six feet deep dug in the glacis. The average diameter of the excavation made by the explosion is said to have been thirteen and one-fifth feet. The sole object of the test is stated to have been to prove the validity of the claim that terrorite exerts its effect uniformly in all directions. A second explosion of a shell buried in a similar manner to a depth of seven feet excavated a hole twelve and six-tenths feet in diameter. The charge in the first of these experiments was 12 lb. 7½ oz. In the second experiment it was 11 lb. 13oz.

MECHANICAL or Forced Ventilation was recently the subject of a lively discussion in the British Association; the debate having been called out by a paper describing arrangements for warming and ventilating Victoria Hospital, Glasgow, designed by Mr. William Key, a member of the association. The system described is one of plenary ventilation, the air being forced in at the base and educted at the roof. The air is also filtered through a dampened screen made of suspended cords of horsehair and hemp, for the removal of dust. The cords are kept moist by water trickling down their surfaces, a portion of the air being warmed by steam coils after passing the screens, and then mixed with other portions of filtered air at the temperature of induction, by which means the exact temperature required in the air inducted to the wards is attained. Mr. Key's description of his method of mixing the air is not entirely clear, but as we understand it the portion of the air which is heated after passing through the steam coils is returned to the induction side of fans forcing in cold air and passed through them. If this be the case, the air passed to the steam coils would have the temperature of the mixed air, and this would require a larger heating surface than would be needed were the air inducted to the steam coils directly from the exterior of the building. The screens are washed every twenty minutes by the use of an automatic flush-tank, and it is stated that fog as well as dust is eliminated from the inflowing air. Otto gas-engines are used to drive the fans. The building incloses a space of 400,000 cubic feet, and 2,400,000 cubic feet of air are inducted each hour, changing the air once in every ten minutes. This is effected, without drafts, by inducting the air to the wards through wide shallow ducts, opening five feet above the floor, their openings into the wards being directed towards the ceiling. The eduction from the wards is made through ducts leading from the floor level to the roof. In his paper Mr. Key very properly deprecated the practice of blowing cold air into the whole basement of any building. A portion of his paper which was challenged, was the statement of the advantages of the dampened screens as compared with dry ones, although the successful operation of the system in the Victoria Hospital was freely conceded by all who took part in the discussion. On this point our opinion coincides with that of Mr. Key, because the dampened screens effect two very desirable objects, the moistening of the air as well as removal of dust; whereas dry screens, have no effect upon the hygrometric condition of the air inducted.

A Protest Against Excessive Use of Iron and Steel in Building is contained in an editorial of the *National Builder* (Chicago) for August. A point made in this article is that the use of iron and steel for foundations of buildings as recently practised in Chicago for what the *Builder* styles "sky-scraping edifices," has been adopted without adequate consideration of the ultimate uses to which such buildings are to be put, or "the danger to be apprehended from fire." The article further asserts that "in the construction of buildings of this character, the method has of late been adopted by which an exterior covering may be attached to the steel frame work, thus deceiving the public into the belief that the walls are veritably fire-proof, when, in fact, they are but a hollow

mockery and sham. The *Builder* backs this assertion by calling attention to conflagrations in which "so called fire-proof iron and steel buildings have been rendered useless and dangerous." It is also pointed out that the interior use of wood for floors, doors, window casings and partitions, commonly introduces enough combustible material into this class of buildings (leaving out the introduction of desks, furniture, and other free burning articles by their occupants), to endanger the structures in case of fire, through the heating and consequent weakening of the metal supports. The article concludes with the following severe criticism:

"Especially to be condemned is the method of framing up story after story of cast iron columns and steel girders to the height of ten or more stories without an interior wall or partition to, in a measure, assist or relieve any unusual or moving strain on the upper portions acting transversely on the columns of the lower stories. Nor can any reliable architect endorse the use of an exterior covering anchored to the frame, even if it is composed of fire-proof material, from the fact that in case of fire it would detach itself and carry destruction to surrounding buildings in its collapse. It may be all very well for some architects to write themselves up in the daily press as engineers of unlimited capacity, but to the thinking and careful constructor and one who by long experience and painstaking study thoroughly understands the true principle of fire-proof construction, this character of buildings are but the evidence of incompetence, inexperience and poor judgment on the part of the designer; in fact, they have nothing whatever to recommend them to the public, and we may safely predict that the first serious fire in any one of them will forever stamp the principle employed in their construction as crude and faulty in the extreme."

Steel Construction in New York City, of the kind above criticised is according to *Architecture and Building* (New York), to be carried out in a building to be erected on a plot 162x200 feet adjoining Washington Building near the lower end of Broadway. The plans are said to have been already prepared by Architect F. P. Dinkelberg; and the cost of the building has been estimated as $4,000,000. This building is intended to beat the record in respect of altitude; that is to say, it is to be twenty-six stories in height. The journal named says that "Mr. Dinkelberg has eliminated the walls from his calculations entirely. Stone walls there will be, part of the way up, but their object will be show, not utility. They will be required to bear no weight. There will be brick, or rather terra cotta blocks to the very top of the big building, but their outward appearance of massiveness will mean nothing. The building will derive all its strength from within. On Broadway and Greenwich Street the fronts of the main building will rise perpendicularly to a height of 290 feet. The first five floors will be faced with massive granite blocks, giving the whole structure an appearance of great solidity. From there up the fronts will be terra cotta, encasing the steel construction, and laid on for effect, but from the street seeming to be substantial brickwork to the roof. The terra cotta will be pale yellow and mottled. The great tower also will have a terra cotta skin. It will rise 260 feet from the roof of the main structure, and will be topped by copper pillars and a dome. The apex of the dome will be 550 feet above the surface of Broadway." This statement, when considered in connection with the criticism of the *National Builder*, is calculated to set sober minded people to thinking, and in the opinion of the writer it is high time some sober thought was bestowed upon this modern Tower-of-Babel craze.

The Odd Fellows' Temple in Chicago is to be another example of the high building mania. The total height is to be 556 feet including the tower; but the main part of the building is to be twenty stories high. A correspondent of the New York *Tribune* says that the plans provide for the building of the entire ground space up to a height of fourteen stories. Above this the building extends six stories in the form of a square cross, the four spaces at the angles of the main building being left vacant. Above all this will be reared the tower. How, with such a design, any architectural effect, except that of a strained effort to outdo something or somebody, can be achieved, will be incom-

prehensible to those who endeavor to conceive what such a structure must look like.

The Inutility of the Building Law, so strongly insisted upon by Mr. John Beverley Robinson in our August number, received, as we were going to press with the September number, a fearful confirmation in the fall of the building in Park Place, New York City, and the sudden and awful death of sixty-three persons. This building designed originally for an office building by its able and conscientious architects, Messrs. D. and J. Jardine of New York City, was overloaded by ponderous printing presses, lithographic stone and other lithographers' materials, and the vibration caused by the action of the presses together with the undue weight, caused the disaster. The architects named are quoted as saying that the building was "never designed for presses, and no one with common sense would have put presses in it." As proof of this fact one of the firm produced the original permit for the building, which stated that the building was designed for offices and lofts. This gentleman is also quoted in the New York *Sun* as stating that the safe load for the floors was 200 pounds per square foot. It appears from evidence taken at the coroner's inquest that the load was very much in excess of the safe load, which statement was confirmed by the architect in his testimony at the coroner's inquest. The result of the inquest is that the building broke down, the immediate cause being a shock of some sort, whether by the fall of a heavy body or by an explosion of benzine it was impossible from the evidence to determine. That there was any explosion adequate in itself for the complete destruction of such a building there was no proof; and it is generally believed that overweighting was the main cause of the fall of the building and the lamentable loss of life attending it.

Movable Walls for Theatres that can be moved bodily in one or another of three different ways in case of fire, leaving the interior space entirely open, is a recent French invention. A movable stage and a movable floor in a theatre are not new devices. The former is an invention of a well-known American actor and playwriter, and is now in use at Madison Square Theatre in New York City. The stage has two floors upon which alternate scenes are set, one being arranged during the presentation of another to the audience, in order to shorten the waits between the scenes. The different platforms or floors are brought to the proper level in the auditorium by hoisting or lowering the entire stage. The movable floor was also designed for use in case of fire, but it has never come into general use. The present invention of movable walls may meet a similar fate, as architects will doubtless see many practical objections to the scheme. The three ways of moving the walls are described in *Invention* (London) as follows:

"One method is that the walls, which are of two sheets of iron having the space between filled with cork, refuse or any light material that will not affect the heat or sound injuriously, are suspended by cables running over pulleys fixed to the upper part of the building. A balance weight is attached to each end of the chain, and the weight is connected with a windlass placed in the basement. In case of fire the windlass is put out of gear, and the wall descends by its own weight to the space provided for it in the ground. In the second alternative system, the walls of each story are mounted on hinges, and connected outside by cables and balance weights communicating with a windlass. It is only necessary to ungear the windlass for the walls to descend like a drawbridge and resting on the balustrades, to form so many balconies from which the outer staircases reach the street. The third system, specially adapted for buildings with only one side free, allows the wall to move horizontally through grooves worked by roller and balance weights, leaving an opening corresponding to its own width. Steam, electricity, or any other motive power can be used to work the windlass and the undergearing."

Tests of Cement Mortars recently made at the laboratory of the Illinois University to determine resulting strengths of different proportions of lime, have added important data to the heretofore existing knowledge of this subject. The lime used in the tests was a good quality of ordinary fat lime slaked for two days in two parts by weight of water to one of the lime

The following tables taken from an extended report of the tests printed in the *Railroad Gazette* exhibit the results:

COHESIVE STRENGTH.

Per cent. cement.		Pounds per square inch. Age 4 days.	Age 7 days.	Age 14 days.	Age 21 days.	Age 28 days.	Age 56 days.	Age 84 days.
0%	Lime M't'r	4	8	10	13	18	21	26
20%	Rosendale,	5	8¼	9½	12	17	17	18
	Portland,	5	8¾	14	20	25	24	26
30%	Rosendale,	7	11	13	18½	21	22½	23
	Portland,	8	16	18	22	25	28	27
40%	Rosendale,	10	12	16½	21¼	22¾	24	36
	Portland,	27	39	38	43	47	59	57
60%	Rosendale,	9	13	20	16	22	22½	23
	Portland,	45	58	55	68	67	102	78
80%	Rosendale,	12	18½	22	27	29	31½	33
	Portland,	87	91	103	124	94	210	145
100%	Rosendale,	18		26	31	34	46	48
	Portland.	90	120	146	152	181	205	202

COST, STRENGTH AND EFFICIENCY OF THE SEVERAL MORTARS.

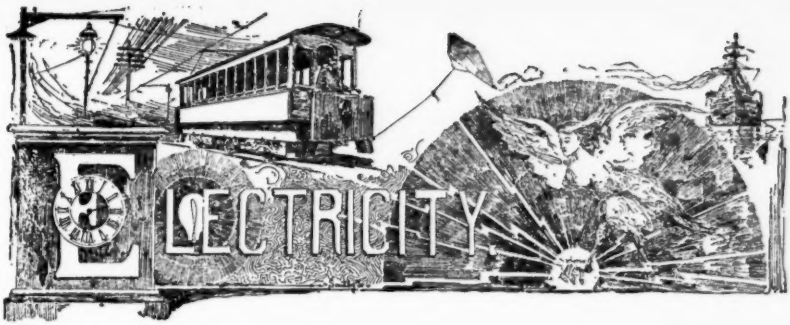
Cementitious material. Composition in per cents. Lime.	Cement.	*Cost per cubic yard of mortar, cost of sand not included. Lime.	Cement.	Total.	Relative.	Mortar. Strength. Pounds per sq. in.	Relative.	Relative efficiency, i. e., strength ÷ cost.
0	100	$1.00	$7.46	$7.46	1.00	85	1.00	1.00
10	90	.10	6.71	6.81	.91	84	.98	1.09
20	80	.20	5.97	6.17	.82	78	.92	1.11
40	60	.40	4.48	4.88	.65	48	.57	.86
60	40	.60	2 98	3.58	.48	35	.41	.85
80	20	.80	1.49	2.29	.31	20	.24	.76
90	10	.90	.75	1.65	.22	14	.16	.74
100	0	1.00	.00	1.00	.13	12	.15	1.05

Hardening Plaster for Use in Floors is said to be accomplished by a French process and is described in *Invention* (London), which states that a good hard floor may be made by it. "About six parts of good quality plaster are intimately mixed with one part of freshly-slaked white lime finely sifted. This mixture is then laid down as quickly as possible, care being taken that the trowel is not used on it for too long a time. The floor should then be allowed to become very dry, and afterward be thoroughly saturated with sulphate of iron or zinc—the iron giving the strongest surface, the resistance to breaking being twenty times the strength of ordinary plaster. With sulphate of zinc the floor remains white, but when iron is used it becomes the color of rusted iron; but if linseed oil, boiled with litharge, be appplied to the surface, it becomes of a beautiful mahogany color. Especially is this the case if a coat of copal varnish be added."

The Output of Lumber from the Mills and Forests of Michigan, Wisconsin and Minnesota, known as the White Pine Group, has been published in a bulletin of the Census Office. This shows that there has been an increase of the total product in these States since 1880 of 29.66%, while the value has increased 75.92%. The increase of the number of hands employed is 138.49%; the increase in wages is 140.26% or a very little more than the percentage of increase in the number of hands employed. In 1880 there was employed in the lumber business and forest industries of these States a capital of $65,855,632. At the census of 1890 the capital invested was found to be $223,386,607.

The Cleaning by the Sand Blast Process of the marble front of the U. S. Assay Office in this city has been so interesting a process as to attract crowds of spectators while it was in progress. The improvement in the appearance of the building is very great, and the efficiency of the sand blast for this kind of work is well indicated by the result. The rapidity with which the work can be done is one of its chief merits. It is also a much more cleanly method than the use of chemicals.

A Decision of the Utmost Importance to Architects and Builders has just been rendered by the Supreme Court of Massachusetts which is, in substance, that the lowest *invited* bidder for a contract is entitled to recover damages if it is not awarded to him. The decision was made in the case of McNeil Brothers vs. the Boston Chamber of Commerce, the plaintiffs having been the lowest bidders for a building contract, which was not awarded to them. Damages to the extent of $14,500 were awarded in a lower court in a trial before a jury. On questions of law relating to the legal standing of the Building Committee which awarded the contract the case went up to the Supreme Court, from whose decision there is no appeal.



THE Conversion of Water Power into Electromotive force, which can be distributed to considerable distances with little loss, having now been demonstrated as practicable by numerous plants erected and in successful operation, it is reasonable to suppose that this system will have some effect upon the selection of sites for new towns, particularly such as are to thrive upon manufacturing industries. In the far future, perhaps, when coal-beds are to a great extent exhausted, the location of a city near a large water power may be the condition for economically and comfortably heating its dwellings. The amount of heat which may be represented by a water fall is very strikingly illustrated in the able article contributed to the September number of this magazine by Mr. Coleman Sellers, in which he says "that the theoretical value of the water that passes over the crest of this mighty dam (Niagara Falls) has been represented as requiring all the coal that is now being mined in the world daily burned as fuel to make steam sufficient to pump back the same quantity of water." It can be easily shown that the work actually performed by this fall of water is, according to the above estimate, sufficient, if converted into heat, to represent the heating capacity of about one tenth of all the coal mined in the world at the present day.

"The Telephone in '93," is the title of a paper contributed by Mr. Herbert Laws Webb to the *Western Electrician* in which he exhibits not only very sound judgment but also a practical knowledge of the ins and outs of telephone practice, of which the need is very conspicuously exhibited in articles which have been written by others about the cheap telephone service we may expect upon the expiration of the Bell patent. Mr. Webb throws a great deal of cold water upon these pleasant anticipations. He points out, that even if the field should become free from competition on the expiration of the Bell patent, the business will still be protected by the numerous devices that go to make up a complete telephone system. The desired result might have been realized in the earlier days of the Bell patent if it had been defeated in any of "the strenuous attacks made on it." In that case he shows that the public would have acquired a very different thing from what it will acquire in '93, which will be simply "the Bell telephone receiver and the right to transmit speech by means of undulatory currents of electricity." Then Mr. Webb, very pertinently asks, "What will the public do with the receiver and the undulatory currents when it gets them?" "Do newspapers, or does the public imagine that all these countless devices, instruments, circuits and systems will be thrown in gratis with the receiver in 1893?" The Bell Telephone Company have acquired "patents for every other form of instrument and apparatus connected with telephony," and "these patents form as it were a very strong inner wall of defense which will prove a formidable obstacle to those intending to compete with the existing telephone companies." Besides these Mr. Webb also points out that "there are outer works of a nature and strength which will be very difficult to overcome." Of these he means "the strongly established position in which al the telephone companies in the large cities of the country are entrenched. Every

day it is becoming more difficult to run wires from point to point. Overhead they are prohibited by the municipalities; underground the municipality steps in again and says the streets shall be disturbed no more." Still another difficulty will be the limited supply of engineering talent, a very high order of which is necessary for the conduct of the telephone business. Other difficulties in the way of the anticipated cheap telephone service are pointed out, and altogether the article is one of the best and most readable which has been published in any of the electrical papers during the past two months. The article takes a thoroughly practical and inteligent view of the subject and will have a healthy effect upon the public mind.

A Novel Machine exhibited at the late agricultural show at Doncaster, England, was one designed to remove bolts, nuts, nails, horseshoes, etc., from bones, oil cake, or minerals, before they are passed into disintegrating machines, as the presence of these foreign bodies is very detrimental to the machines. The *Electrical Engineer* in describing this machine points out that "the chief difficulties that had to be overcome in designing it were the large size and irregular shapes of the material to be treated, and the fact that the iron, particularly in bones, is frequently entangled in the bones, so that merely passing the substance once over or on to a magnet was not found sufficient to ensure the absolutely certain removal of the foreign substances. These points have been satisfactorily overcome by the use of a hollow truncated cone, with ten internal magnets, of alternately opposite polarity. The cone revolves on outside runners, driven by friction only, which is found ample for the purpose."

A New Electrical Type-Setting Machine is stated to have been invented by Mr. C. L. Redfield, of Chicago. The machine is claimed to be very simple and practical. Doubtless the apparent applicability of electricity to operating the mechanism of machines in which many parts of similar kind are successively to be moved, as in calculating machines, recording mechanism and type-setting machines, has often occurred to electricians; but, so far as we know, this is the first realization of this possibility in a type-setting machine. However, this machine appears not actually to set type as does the now famous Thorne type-setting machine. It is, rather, a machine for forming a matrix, from which plates for printing can be formed by electrotyping. As described, "the power for making an impression with the type is furnished by an electric motor. The impression is made by the type on card-board, especially prepared for this purpose, which costs a trifle more than ordinary paper. The impression on the cardboard leaves a matrix ready for pouring in the electrotype composition to form the plate." It is further stated that the work of ten ordinary compositors can be done with this machine; and that the difficulties of justification and other conventionalities of printing have all been practically surmounted. How far these claims will be verified remains to be seen.

The Government Test of the Sims-Edison Torpedo recently made at Willet's Point, has, in its results, confirmed the high opinions of its merits which have been entertained by competent judges of such matters. In every respect the torpedo tested behaved in the most satisfactory manner. It made a speed of twenty miles an hour by electric propulsion, and was steered with accuracy by its electric steering apparatus. The United States Government was represented on the occasion by Col. W. R. King who has charge of the torpedo station at Willet's Point. Several other military and naval officers together with some prominent electricians and representatives of foreign governments were present on the occasion.

The Platinum Industry of the Urals has been described at length in a recent number of the *Scientific American Supplement*. As this metal is used more largely in electric lamp-making than in almost any other industry, an abstract of the facts stated in the article named will be interesting not only to electricians but to the general reader. The platinum of Russia comes from the district of Peria. The output in 1885 was 110,635 ounces; in

1886 the output was 184,336 ounces, a very notable increase. Platinum has also been found in alluvial deposits, also associated with gold, the platinum sometimes being in greater quantity than the gold and in other situations not more than 1% of the weight. The ore is most profitable to work when it contains little gold. The most important deposits are in the district of Nijni-Taguil near the water shed of the Urals. The platinum-bearing streams of this locality descend from Mt. Solovskaia. This mountain is composed of serpentine rock. The rivers flowing from this mountain through the wide valleys contain alluvial deposits in which there is more platinum than gold. Between Mt. Solovskaia and Mt. Blanc the surface is covered with rounded boulders of serpentine and peridotite rock, which decompose under the action of the air, forming a sand or gravel from which the metal can be profitably extracted. The action of atmospheric influences upon this rock is similar to that which takes place upon the diamond bearing peridotite rock of Kimberley in South Africa described in the August number of this magazine in the interesting article contributed by Mr. Stonestreet. The platinum is found in grains and, rarely, in nuggets, of which one is said to have been found which contained 10 kilograms. When the gravel contains 1-10 of an ounce per ton it may be profitably worked ; but it often contains as much as ½ an ounce per ton. The deposit near the banks of the river Martiane rests on a serpentine conglomerate and is from 4 to 5 meters in thickness. It is covered by from 23 to 24 metres of earth, chiefly clay, which has to be removed. The gold deposits near the head of the river Miass are rich in platinum. Further down stream the gold becomes less platiniferous and small nuggets of platinum are sometimes found imbedded in pieces of serpentine, peridote, or chrome iron ore which constitute the peridotite rock. From this it appears that the peridotite is the true mother rock of the platinum. The richest deposit of all is at Avrorinski. Its length is 2 kilometers; its width 20 to 60 meters; and its thickness 4 to 5 meters. The amount per ton of the gravel is from 4½ to 5 ounces on the average, and it sometimes reaches to 9 ounces. As these deposits also contain but a small proportion of gold they are exceedingly profitable. The crude platinum obtained from these deposits contains about 90% of the pure metal. The appliances for obtaining the metal are of the crudest possible kind. The washing and other machinery are made by the peasants, chiefly of wood. Some platinum is taken from the beds of the rivers when these are found sufficiently platiniferous to pay for working. In such case the course of the river is diverted and water power is used for driving the machinery.

Lightning and Hail with reference to the damage caused by these violent meteorological phenomena have been made the subject of systematic investigation by Dr. C. Lang, director of the Bavarian meteorological service, and he has contributed to *Nature* an excellent article entitled "Secular Variations of Damage by Lightning and Hail," embodying therein interesting results of his observations. He concludes that the belief hitherto seemingly sustained by reports of other investigators, to wit, that damage from lightning has increased during the last half century is not sound. Greater attention has been paid to the subject during recent years, and a more general publication of damage from lightning accounts for the supposition that such effects are on the increase. The numerous impurities introduced into the air of towns from fire-places, etc., would make it probable that they would be more liable to damage than country places, but exactly the opposite is the case, the ratio of damage to buildings in towns to that in the country being 1 : 2. This result is, possibly, to some extent due to the more numerous lightning-conductors, and to railway lines in the towns. He thinks "damage from hail shows a very probable connection with the period of sun-spot frequency, but the secular range of the former points more particularly to the influence of temperature, so that the curve of hail-frequency shows not only a minimum occurring with the 11-year sun-spot maximum, but also a period of about 35 years. The damage from light-

ning, on the other hand, does not show any connection with a secular range of temperture, but the minimum occurs with the maximum of sun-spot frequency. In other words, damage from hail seems to be more decidedly connected with terrestrial, and damage from lightning more with cosmical, influence."

The Application of Electricity to the art of tanning is a recent innovation, which, during the past two months, has been considerably discussed in electrical publications. It appears that, under certain conditions, the passage of an electrical current through the tan-liquor in which the hides are immersed has the effect to hasten greatly the absorption of tannin by the animal tissue. The effect of artificial motion of the hides in the tan-liquor is peculiar, the absorption of the tannin taking place more rapidly in a period of rest after motion than during a period of motion. The following comparison of rates of tanning under different sets of conditions is taken from the *Electrical Review*, London. The first column of figures in the table gives the loss of tannin from the tan-liquor in the different experiments and the last column the rate:

Kind of tanning.	Total loss in parts per 10,000.	Total time in hours.	Rate.
Ordinary tannage.....	12 8	88	0.145
Rest after motion and electric current.....	15.3	56	0.273
Rest after motion alone..	15.7	56	0.280
Motion after electric current.....	8.6	24	0.360
Motion alone.....	18.8	38	0.490
Motion and electric current.....	53.6	38	1.420
Electric current after motion.....	59.0	24	2.470

The Deptford (England) High Tension Scheme, with which the name of Mr. Ferranti has been so prominently connected, and the gigantic dynamos of which have furnished material for illustrations and descriptions in the electrical papers, has furnished new matter for sensational journalism since our last number went to press. First there came a rumor that Mr. Ferranti had suddenly left England. Inquiry developed the fact that he had certainly severed his connection with the Deptford scheme, after that had involved its promoters in an expense of £600,000 for plant and mains. Some English electrical papers, particularly the *Electrical Review*, have regarded the success of the scheme of carrying a pressure of 10,000 volts as, to say the least, problematical, though these papers have generally united in praise of Mr. Ferranti's courage, energy, enthusiasm, and mechanical resources. The immediate cause of the rupture has not been made public. The company continues its business however.

The Splitting of a large Cedar Tree by Electricity is spoken of as though it is somewhat unusual occurrence in the *Electrician*, London. This cedar was about 14 feet in circumference at the base, and stood on a hill near the village of Montacute (Somerset), England. The journal quoted states that the discharge, after severing the top into several pieces. ran down the front splitting it into two parts, nearly 50 feet in length. It does not state the variety of cedar. The writer has several times seen a similar effect produced on white cedar in the cedar swamps of this country. This timber splits with greater ease than almost any other. It is not an infrequent occurrence that a portion of the trunk of a white cedar tree, say, 16 feet in length, will split from end to end by the wedging action of an axe struck into the end of the log. The effect of lightning on other trees which do not split so easily, as generally also upon the cedars themselves is to plough out a groove in the exterior of the trunk. Generally also there is some shattering action in the tops of the trees.

A New French Invention is the chlorochromic battery of Commandant Renaud which, according to *La Lumiere Electrique*, is to be used for a miner's safety-lamp, and the power of which is such that the electricity and its battery weighs but little more than the oil lamp usually employed. The light supplied by the use of this battery costs little and is of much greater illuminating power than that of the ordinary miner's safety-lamp. Experts have expressed the opinion that it is impossible for this lamp to cause an explosion in a mine.

COAL in Colorado, exists in large quantity in the Las Animas coal fields which are described in the *Mining and Scientific Review* (Denver), as of great extent and importance. The paper named states that competent judges estimate 1000 square miles to be underlaid with coal. It further states that the "deposits lie along the hillsides, in layers, showing three and sometimes four distinct strata. The upper is lignite, three to four feet thick, light and of no material value except for domestic uses. The third is the one most worked, and most valuable, generally fine coking coal, soft, pure bitumen, eight to ten feet thick. It cokes readily and makes as fine an article as any coal in the world, in some respects superior to that of Connellsville, Pennsylvania. At the present time the miners are raising about 6500 tons a day and shipping it to various markets." With this statement about the coal fields of the Las Animas district is coupled a denial of the existence there of iron ore (as has been asserted) except in bonded veins too thin for working, and mostly limonite.

Deep Mining, defined by the *Mining Industry and Tradesman* as mining at a depth of from 3000 to 4000 feet or deeper, has been recently discussed at length in that paper. The limit of between 3000 and 4000 feet which was formerly supposed to be extreme has been indefinitely extended by modern improvements, among which the electric hoist is named as removing, or at least greatly reducing, the mechanical difficulties of deep mining; and the various applications of electricity to pumping, drilling, etc., are full of promise in the working of deep mines. With reference to the high temperatures which have so often seriously impeded working at great depths, the journal quoted says that the average increase in proportion to depth is considerably less than has been estimated, and that the difficulties experienced in thermometric readings in deep bore-holes has probably given rise to error in such estimates. In proof of this it cites the "Lake" copper mines, in which it is asserted, very little difference in temperature exists between the 1000-foot and the 2000-foot levels, such variations as are noticed appearing to depend more upon the candles, animal heat, and differences in ventilation than upon the depths. Underground temperatures are often dependent upon local influences of heated water. The refrigeration produced from the exhaust of drills operated by compressed air, helps materially in the control of temperatures.

A Rare Copper Ore is described as found in Grant County, N. M., by a correspondent of the Silver City *Sentinel*. It is a pseudomorph taken from the Copper Glance and Potosi Mines. He says "the mines down to a depth of near 70 feet contain ore consisting of azurite, malachite, red oxides, glance, etc., and below this depth the above-named pseudomorph, which is in reality a brittle native copper, mixed with a fine white earth and silica, some of the specimens of which are very beautiful and in all imaginable shapes. Some are perfect roses in shape. These no doubt were once azurites as their crystallization indicates. But there are other specimens very different in appearance in which the crystallization differs very materially if not altogether; which indicates that they once existed in the form of malachite, glance, red oxide, etc.; and the fact that the mine nearer the surface contained all of these ores and all having been changed to the brittle native below would

certainly prove that these were all changed by the same process, whatever it may have been, into their present form."

A New Alloy of Aluminium and Titanium discovered by Mr. J. W. Langley is attracting attention on account of its almost wholly incorrodable quality. It is said to consist of varying quantities—ranging from 0.5 to 10 per cent.—of titanium combined with pure aluminium. The alloy can be hammered or rolled with ease; and, by rolling, it acquires considerable elasticity. The fusibility of the alloy is said to be dependent upon the amount of titanium contained in it. Both the fusibility and the malleability appear to decrease with increase of the titanium. The fusing point is placed as somewhat below that of steel. The *Electrical Review* (London) gives the following formula for the manufacture of this alloy:

"A bath of pure fluoride of aluminium is prepared in a carbon crucible, the oxide or other salt of titanium added, well mixed and allowed to dissolve. When the mass is thoroughly incorporated, and quite fluid, metallic aluminium is charged in, the relative proportions of aluminium and oxide or salt being such that the percentage of oxide shall be about twice the percentage of metal required in the alloy. The temperature of the crucible rapidly rises on the introduction of the aluminium, and as soon as it ceases the reaction is completed, and the mass run out into another vessel, when, after cooling slightly, the slag is run off.

"The fluoride of any metal more electro-positive than aluminium may be used in the bath, but cryolite should not be employed, because it contains iron; fluoride of sodium or fluoride of calcium may be employed with advantage.

"Chromium may be introduced into the crucible as an oxide if it is desired to combine this metal with the alloy of aluminium and titanium."

Another New Alloy has been discovered by Mr. Harrington, the patentee of carbon bronze. An account of this new metal has been printed in the Pittsburgh *Dispatch* from which it appears that the alloy under consideration is an improvement upon the original carbon bronze, in the formation of which new alloy manganese plays some part and which is therefore called the Harrington manganese bronze. However, its constituents are stated to include also iron, copper, zinc, tin and other ingredients which the discoverer elects to keep a secret as yet. It is certain that if the statement concerning this metal can be substantiated it must prove of great value in the arts. Among the most important and valuable properties claimed for it is its resistance to the action of sulphuric acid which will adapt it to use in the vessels employed for concentrating this acid, as a substitute for platinum and glass, the materials hitherto used, either of which form a large item in the cost of manufacture. Mr. Harrington claims to have immersed fine shavings of the alloy in pure sulphuric acid for a period of five weeks, the metal showing neither discoloration nor loss of bulk during this severe test. It is further said that Messrs. James L. Morgan and Son, of New York City, placed a sample of the metal in boiling commercial sulphuric acid and kept it there for six weeks without its losing weight. Tests of the metal made respectively by Prof. R. H. Thurston, of Cornell University, and Dr. C. H. Dudley, the chemist of the Pennsylvania Railroad, at Altoona, gave some remarkable results. Professor Thurston found the tensile strength to be 75,000 pounds to the square inch; the breaking load, 91,000; transverse test, 98,000, and the crushing strain, 128,000 pounds to the square inch. Heretofore the strongest bronze ever made was found by Professor Thurston to have a tensile strength of 60,986 pounds. The piece of metal used in the transverse test was tested by Dr. Dudley. He broke the piece into two and tested each as follows: No. 1—Tensile strength, 73,000 pounds; elongation, 19 per cent. No. 2—Tensile strength, 74,000 pounds; elongation, 16 per cent. Dr. Dudley, in referring to the metal, says: "Chemically, the metal is an alloy of copper, tin, zinc and iron. There is a little doubt as to whether all the metal put down as tin is tin, but we have not succeeded in finding anything else. It will be noted by comparing the analysis with the principal tests that the metal is a very wonderful one." A tube of the metal formed by casting a cylinder and boring it out to leave a shell one-

eighth of an inch thick is said to have withstood an internal pressure of 2200 pounds per square inch without the least sign of giving way. This test was performed at the Etna Tube Works. A cock made from this metal has been placed on an agitator at the Standard Oil Company's refinery at Lawrenceville. Whereas, three weeks is the maximum term of service such cocks have hitherto given, that made of the new metal, though put in use on July 15 of the present year, is still working and apparently good for three months' further use. The metal is also said to be much stronger when hot than cold. The color resembles that of red gold. It may be rolled into sheets, forged, cast, or drawn into wire. It works easily under the file and takes a high polish. Truly this is such a category of properties when considered as belonging to a single alloy, that it is difficult to believe some exaggeration has not crept into the statement. A metal possessing them all would be an addition to present mechanical resources the effect of which would be far reaching. As the discoverer announces his intention to keep the composition a secret, and as Dr. Dudley found no manganese in his analysis of it, it may be that the name, "*manganese*" bronze, is a cloak for concealment, rather than a term rendered appropriate by any use of manganese.

The Determination of the Temperatures in Blast Furnaces, as a means for judging of the action of such furnaces, is the subject of an article recently published in the *Engineering and Mining Journal*, the article having been translated from the German of A. Ledebur, in *Handbuch der Eisenhüttenkunde*, by H. C. Nitze, E. M. Several examples of temperatures are given, one being of especial interest as showing the variation in temperature at different parts of one and the same cross-section of the furnace. The experiments in this example were made with a coke furnace at Gleiwitz running on common white iron. As described by the author of the article, "the height of the furnace from the tuyères to the throat was 13.6 m.; diameter at the plane of the tuyères 2.56 m.; at the boshes 5.34 m., and at the throat 3.92 m.; cubic capacity, 215 cu. m. The temperature of the blast was 350° C.; quantity of blast per minute, about 150 cu. m. The charge consisted of 180 kg. puddle slag, 135 kg. brown hematite, 135 kg. spathose ore (½ raw and ½ roasted), with 165 kg. limestone flux. The run of the furnace in 24 hours was 36 tons, with a coke consumption of 155 kg. per 100 kg. of pig iron produced."

The following were the temperatures in Centigrade degrees:

	Plane of tuyères.	Above Plane of tuyères.						Throat.
		0.44m.	1.47m.	5.54m.	7.64m.	9.83m.	12.03m.	
	°	°	°	°	°	°	°	°
Centre of furnace.	1300	1400	1400	1200	955	850	680	140
Intermediate between centre and circumference.....	1500	1500	1300	1000	700	525	432	to
At the circumference.....	1600	1300	1400	1200	900	815	575	290

A striking peculiarity of the temperature variations is that "at the centre and directly at the walls the highest temperature was found to reign pretty regularly, while between these was a cooler zone. In the upper part of the furnace a more rapid decrease in temperature is noticeable along the walls than at the centre. This phenomenon is explained by the fact that in charging the ores along the circumference of the throat, the coke heaps itself more in the centre of the furnace; the ores, however, require a greater amount of heat, on account of their greater percentage of water than the coke. The higher degree of temperature along the circumference compared with that between the walls and the centre, is explained by the ascension of the gases along the walls of the furnace."

A National Association of Government Geologists has been initiated. A meeting for preliminary action was held at the Columbian University, Washington, August 28, at which the gentlemen named below were appointed a committee to draft a constitution and by-laws: Maj. J. W. Powell, director of the U. S. geological survey, chairman; Prof. E. A. Smith, State geologist of Alabama; Prof. J. A. Holmes, State geologist of North Carolina; Dr J. C. Brauner, State geologist of Ar-

kansas; Mr. Arthur Winslow, State geologist of Missouri, and Prof. W. H. Winshell, State geologist of Minnesota. The objects of the association are announced by the committee as follows:

1. The determination of the proper objects of public geological works.
2. The improvement of methods.
3. The unification of methods.
4. The establishment of the proper relative spheres and functions of national and State surveys.
5. Co-operation in works of common interest and the prevention of duplication of work.
6. The elevation of the standard of public geological work and the sustenance of an appreciation of its value.
7. The inauguration of surveys by States not having such at present to co-operate with the other State surveys and with the national surveys.

The Use of Modern High Explosives in mines with relation to the effect upon the health of workmen of the gases produced in firing, was, from the strength of numerous complaints made by the workmen in collieries, made the subject of investigation by a committee appointed in the autumn of 1889 by the Durham Coal Owners' Association, England. The committee was empowered to call to its aid the counsel of professional advisers. In accordance with this authorization, Prof. P. Bedson, chemist and expert, was employed. The medical problems involved were submitted to Drs. Drummond and Hume. The investigation was very thoroughly made; and the conclusions reached appear entirely reliable. A very full account of the methods employed is given in *Industries*, London. The new explosive *ammonite* described in the department of Civil Engineering in our September number, having been introduced since the work of the committee was finished, was not included in the investigation. The explosives to which attention was directed were tonite and roburite. The conclusions reached by the experts as published in the journal named were that (1) the fumes produced by tonite and roburite are not more dangerous than those from gunpowder; (2) nitrobenzine is apparently not produced by the combustion of roburite; (3) the carbon monoxide produced is present only in traces; (4) an interval of five minutes should be allowed to elapse before the hewers re-enter the scene of firing; and (5) that, as a portion of the gases in the fumes comes from the fuse, the charges should be fired by electricity.

Of Ammonite we gather from the same source as the above a more definite statement of its composition and other interesting particulars. It contains 81.5 parts of ammonium nitrate, and 8.5 parts of mononitro-naphthalene. It is of equal projectile force to roburite, and superior to tonite in this respect. It cannot be exploded by concussion, and burns quietly on an ordinary fire. Its properties are not affected by freezing. It requires rather a large proportion of detonator to produce explosion.

An Important Draining Tunnel at Centralia, near Ashland, Pa., has just been completed. It is one of the largest tunnels in the United States, consisting of a main tunnel 6000 feet in length and 7x11 feet in section with extensions and branches to reach various mines it is to drain which are about 3800 feet in length, making the tunnel some 9800 feet in all, to which some further additions will be made. With the completion of this tunnel a number of the local mines can be extended, and it will be possible to continue the working of the celebrated Mammoth vein, on which very little has been done for some time past on account of the great expense of pumping. The tunnel is intended for draining a number of coal mines in the Centralia basin of the anthracite region.

One of the Most Promising Silver Mining Properties in New Mexico, is the Teel and Poe mine near Deming. The Deming *Head-Light* in speaking of this mine says that a strike has been reported on it exposing an immense body of valuable ore. The Summit mine belonging to the same company is also yielding finely, and all indications point to a greatly increased output. The company has been doing a splendid business. Their dividend for the month of June was 2%.

THE Pelton Water Wheel is probably to be no exception to the rule, that the patents of important inventions are generally infringed. We are told of a New England wheel which comprises some of the vital features of the Pelton; and, in England, a water motor, to which has been given the rather startling name of "Demon," has made its appearance. *Engineering* (London) described and illustrated this wheel in its issue of August 28th, and in principle it appears to differ in no essential respect from the Pelton. This wheel is being introduced by Mr. P. Pitman of Aubrey-road, Withington, England. We understand that the Pelton wheel is patented in England, and if we are correct in our supposition, Mr. Pitman will be likely to find the continuance of the manufacture of demons a business entailing some penalties as well as profits.

A Locomotive to Run One Hundred Miles an hour has been designed by Mr. Jackson Richards, master mechanic of the Philadelphia and Reading Railroad. By the Boston *Post*, Mr. Richards is quoted as saying: "If the new engine I am about to have constructed is not capable of making one hundred miles an hour, I'll give her away to the first man I meet." It is further stated that an engine built after Mr. Richards' design will be exhibited at the World's Fair in Chicago. Although one hundred miles an hour is within the designer's estimate of the capacity of the new locomotive, eighty-five miles is the speed which it is designed to run at in ordinary use; and this speed, in view of speeds attained by existing locomotives in short spurts, does not much stagger belief. The question of high speeds on railways is however, like high speeds in ocean travel, a commercial one as well as one of engineering. Engines that will run a hundred miles an hour will, we think, require a reconstruction of roads to render such speed permissible.

A New Material for Steam Pipes is, according to *Invention* (London), the fibre of Ramie, hardened under tremendous hydraulic pressure, and possessing a tensile strength equal to two and one-half times that of steel. The ramie fibre, or China grass, has the property of being unaffected by moisture; it will not shrink nor swell; it is a non-conductor of heat; it cannot rust; and as these features, together with its great strength, are all desirable in steam pipes, its utilization in this line is regarded as one of the possibilities of the future. Without exactly denying the statement made by our English contemporary, we must be permitted to express our doubts that it will be sustained by facts. Our limited knowledge of ramie fibre makes us skeptical as regards the enormous tensile strength named for the compressed fibre; and we are also skeptical about its capacity to endure, without deterioration, the prolonged action of steam heat. A specimen of this fibre was once used by the writer to form a gasket for the stuffing-box of an air compressor cylinder in which the temperature of the air delivered was about 320° F. Under this temperature the fibre appeared to gradually decompose and become brittle,

as hemp does under similar conditions, showing that in the uncompressed state, at least, the action of heat is deleterious.

The Use of the Band-Saw, in manufacturing lumber, forms the subject of a discussion by Mr. J. H. Miner in the *Southern Lumberman*. He asserts that the band-saw is *the* saw for large mills and for fast cutting, and that it is approaching the record of the circular saw faster than the latter arrived at its present perfection. Notwithstanding this, there are some manufacturers who are sick of band-saws, although others are getting rich from the saving in lumber which band-saws effect. Mr. Miner concludes that "the man who wants the latest improved machinery and thorough, practical men, and who has good judgment, will make a success with the band-saw mill;" and he instances one man, among many, who, after visiting a number of band-saw mills, "built a better mill than any he had seen," and is thus on the road to success. It seems, therefore, that success in making lumber with the band-saw, is as much a question of the character of the man who undertakes it, as of the saw, which under the management of one proves profitable, and by another is regarded as inferior to the circular saw.

An Automatic Starting Gear for small Gas Engines has been much needed. Hitherto it has been necessary to start such engines by hand, making use of the fly-wheel for the purpose, which requires a certain dexterity in order to time the motion with the ignition of the inducted charge as well as the exertion of considerable strength to turn the crank past its dead centre. To obviate this Mr. F. W. Lanchester, an English inventor, has devised a self-starter which seems to meet the requirements of the case in the particulars which have heretofore rendered self-starters impracticable except for the larger class of gas engines. According to *Engineering* (London), it adds neither to the bulk or complexity of the machine (hence does not add to the cost), and it is perfectly reliable in its action as applied to what is known as the "Forward" gas engine made by Messrs. Barker & Company of Birmingham. The illustrations accompanying the description in *Engineering* show that these allegations are substantially true. The extreme simplicity of the device will be apparent to users of gas engines when the action, which readily suggests all the mechanism required, is described:

"Gas is allowed to blow into and through the cylinder until an explosive mixture is created within it, the condition of the mixture being judged by the color of the flame produced by allowing it to blow through an external pilot jet. At the right moment the gas is shut off and the flame strikes back through the blow-off cock, causing an explosion which starts the engine. The back stroke of the piston exhausts the gases, and the next stroke draws in a charge in the usual way; it also sucks in the pilot flame through the blow-off cock, and fires the charge, the engine thus working non-compressively on the Lenoir cycle with an explosion every revolution. Under these conditions a speed of 120 revolutions per minute is gained in a few seconds. A certain speed, less than 120 revolutions, however, is needed to insure a compressed charge exploding in an incandescent tube. When the requisite speed is attained the blow-off is closed, and the cam set to exhaust every second revolution; the engine then works compressively and fires its charge from the hot tube."

A Phenomenon in Friction, noticed in this department in our June number, has received an explanation in *Engineering* (London) which seems in accordance with natural laws, yet which, to the mind of the writer, does not account for all the observed facts. The editor of our ably conducted contemporary states with reference to the ease with which a rotary shaft can be moved longitudinally that "the proportion of the longitudinal to the circumferential frictional resistance would be simply that of the pitch of the helix to the circumference of the shaft." Without either denying or confirming the truth of this proposition, we again call attention to the Rider cut-off as illustrating the fact that motion in one direction lessens friction in any other direction. Now if the parallelogram of forces (which is the mechanical principle involved in the explanation of *Engineering*, as well as that offered by Mr. Coleman Sellers) sufficiently accounts for this, it would appear from a

simple computation whether the theoretical and practical results correspond. In the case of the Rider cut-off slide, with an unbalanced pressure of 105 pounds per square inch upon an area not less than 36 square inches, the slide having a throw not exceeding 4 inches, the writer has frequently moved the slide laterally to its reciprocating direction by the force of only one hand applied to a small hand-wheel on the stem.

The Finest Whetstones for tools in the world are, on the authority of the Curator of the Smithsonian Institute, those made from novaculite, a species of altered schist found in Arkansas. This is the same as that known generally to mechanics as "Arkansas" stone, very largely used for oil-stones, and which combines with rapid abrading quality the no less important property of setting a fine, smooth edge on the tool sharpened by it. Curator Merill says, with reference to this stone, "that the term altered schist means a deposit of a flinty nature usually combined with limestone, the rock thus produced being changed in such a manner molecularly, by processes not altogether understood, as to supply a surface most suitable for grinding Arkansas furnishes the entire supply of novaculite for the United States, also filling a large part of the export demand, which is very considerable. The main deposit of the material is in a single hill about 500 feet high. For the sharpening of keen edged tools, razors excepted, this novaculite is unrivalled. It is a very beautiful stone, of snowy whiteness and is quite costly, because it has to be cut by diamond dust, owing to its extreme hardness."

Dusting Railway Cars by the use of compressed air is an ingenious innovation, said to have been introduced at Portland, Oregon, in the shops of the Union Pacific Railway. The dust is blown out of every crack and cranny by using a hose with an air nozzle; the hose being connected with an air reservoir kept filled by an air compressing apparatus at a pressure of fifty pounds per square inch. Those who have had experience with the force of an air blast delivered under such a pressure as this, will readily comprehend that the work of cleaning is extremely rapid as well as thorough; the dust being driven out of the plush upholstering of the seats almost as completely as could be done by alternately beating them with a stick and brushing them with a wisp-broom, but with far greater celerity, as with the air, the brushing and beating, as it were, proceed simultaneously.

The Use of Steam Mixed with Air in engines has again been attempted (this time in England) by Mr. Edward Field, C. E. Previous attempts resulted in failure. The present effort seems to have captivated the imaginations of some sanguine persons, and it has been heralded as revolutionary in its character. The descriptions which have been printed of the way in which the air is used in conjunction with steam do not encourage belief that anything new and valuable has been discovered; however, this may be the fault of the description rather than that of the method. As a matter of current discussion in the engineering papers this attempt is worthy of mention; but until a clearer statement of the principles which are asserted to underlie the alleged improvement has been made, we prefer to maintain a skeptical attitude as to the economy claimed for it.

The Bursting of Water Pipes by Frost, has been made the subject of an invention by an analytical chemist, Mr. William Dantec of Altrincham, Cheshire, England. The invention, though very ingenious, is very simple, simplicity being often the point which most taxes inventive skill in small inventions. The invention consists in a cup-shaped air-chamber attached to the side of a nipple which can be coupled at both ends to a pipe it is designed to protect, the air being separated from the space in the interior of the pipe by a rubber diaphragm. The pressure of the water in the pipe compresses the air thus isolated by the diaphragm, the latter yielding to the water pressure till the elastic force of the rubber and the air pressure together equal that of the water. Now if the flow through the pipe be stopped, and the water in the pipe be allowed to freeze, the expansion of

the water in freezing compresses the isolated air still further, the diaphragm yielding as the air is compressed, and thus relieving the pipe from a strain that would otherwise be competent to burst it. Any desired number of these chambers can be easily attached to the pipes, either by screwed joints or by soldering.

Another Recent English Invention supplies a much needed means for cutting off large pipes such as water mains, gas mains, etc., while they are lying in an excavation. The tedious, expensive method of chipping a groove around the pipe and breaking it off at the place so weakened, leaving a rough, ragged end, is entirely superseded by this invention, which the *Canadian Magazine of Science* asserts is competent, to cut off a main eighteen inches in diameter in thirty minutes, when operated by the power of only two men. An annular frame clamped to the exterior of the pipe supports a circular stock for a cutter which traverses around the pipe, being moved by a system of gearing also supported by the frame and operated by winches. The journal quoted states that these machines are rapidly coming into favor in England, one being now in use in Liverpool which cuts off pipes forty-four inches in diameter.

A Series of Tests of Efficiency are to be carried out at the Columbian Exposition under the direction of a Committee appointed by the Council of the American Society of Mechanical Engineers. The well-known engineering and mechanical experts, Mr. Charles E. Emery, of New York City, and Prof. R. H. Thurston, have been appointed a committee for this purpose. Both these gentlemen are highly qualified, by education and by experience in conducting such tests, for the work assigned them. Mr. Emery long ago acquired fame by his skillful performance of experiments upon the use of steam in engines and the valuable data secured by them; and he has since had further experience as one of the judges of the Centennial Exhibition in Philadelphia, where he conducted the tests of steam boilers, to say nothing of his private practice, which has been large. Professor Thurston has also acquired a high reputation as an expert, both in this country and in Europe. He was a commissioner to the Vienna Exposition held in 1873, and was a member of the jury of the Paris Exposition of 1889. The tests are, as at present contemplated, to be applied to engines, pumps, systems of power transmission, and other appliances comprised within the scope of steam engineering. They may possibly also extend to tests of gas-engines and hot-air engines.

Charcoal Polishing, as practised by French cabinet makers, gives an elegant dead black color incomparably superior to any black obtainable by painting or varnishing. The process is somewhat tedious, but the most delicate carved tracery is not injured by it, and the general result is worth the time required to secure it. The woods used are those of dense compact grain. The wood is first gone over with camphor water which is followed as soon as practicable with a solution of sulphate of iron to which tincture of nutgalls has been added. This is the black stain which penetrates the pores of the wood to an extent which will bear the subsequent treatment. The next process is to rub the surface with a brush of couch grass. Subsequent alternate rubbing with very soft charcoal containing no sharp grains, as the coal of cork; willow; poplar, etc.; alternated with rubbings of flannel moistened with linseed oil and spirits of turpentine bring the surface to the required finish. The method is much used for the woodwork of mantels, cabinets and furniture. Wood bases and cases for small machines, drafting implements, etc., can thus be given an elegant finish.

A New System of Electric Traction is to be tried on a French Railroad. A Mr. Heilman is named as the inventor. He proposes to place a steam engine and a dynamo on a car. The current from the dynamo is to be conveyed by suitable conductors to the other cars, where it will drive motors attached to the axles of their wheels. The entire train will thus generate adhesion in ascending grades; and it is expected that a speed of 50 miles an hour, on grades of 1 in 200, can thus be obtained.

THE Dynamite Shell, invented by Dr. Joel G. Justin, has been at last brought to such perfection that, on the 10th September, some very successful experiments were made with it at Perryville, Madison County, N. Y. These experiments consisted in firing three shots,—two from a five-inch Parrott rifle and one from an eight-inch Blakely gun. The first shell fired from the Parrott rifle, instead of exploding in and bursting the gun (as has resulted in prior experiments), although charged with forty-one ounces of nitro-gelatine, and fired at a ledge of rock at a range of half a mile with a powder charge of seven pounds, and striking the target with great force, did not explode at all. This is regarded as a conclusive proof that nitro-gelatine shells may be subjected to the most violent shocks both in and out of the gun without exploding. Neither the nitro-gelatine charge nor the inner chamber of the shell were found, after the test, to be in anywise affected by the shock of firing or the impact against the rock. A similar result attended the firing of the second shell from the Parrott rifle into soft earth. The third experiment--this time with the Blakely gun—was made with a powder charge of thirty pounds and a shell containing 150 pounds of the explosive, and arranged to explode after the impact. The shot was directed against the rocky ledge as in the first experiment. The shell was not only safely discharged from the gun, but it exploded precisely as intended, dislodging, it is stated, about seventeen tons of limestone rock from the face of the rock. Those who know the perseverance with which Dr. Justin has pursued and overcome the difficulties of the intricate problem of firing shells charged with high explosives direct from guns charged with powder, will feel like congratulating him upon the success of these last experiments. The adoption of the method in war, if subsequent experiments prove equally successful, is certain; and it will introduce an entirely new phase of military operations.

The Legal Fight Between the Western Union Telegraph Company and the Bell Telephone Company appears not to be ended. Another effort to crush the last named corporation will, it is reported, soon be begun, and as the conflicting interests are each possessed of ample sinews of legal war, the battle is likely to be hotly waged without either asking or giving quarter. The legal historian of the future will find in the litigations which have been and are likely yet to be instituted against the Bell Telephone interest the materials for an interesting chapter. The most sensational feature of the present attack is the position of Judge Lowell of Boston, as regards the alleged ownership of Bell Telephone Company stock by his relatives in 1881, when, on the bench of the United States Circuit Court for the District of Massachusetts, he decided a case involving important interests in favor of the Bell Company; also as regards his acceptance of an appointment as referee in 1886; at which time he acted as referee and rendered a decision in a suit in equity brought by the Western Union against the Bell Company, at which period his relatives are

stated to have been considerable holders of the Bell Telephone Stock. This is one of the principal grounds upon which the officers of the Western Union Telegraph Company are stated to have resolved upon renewing the contest; further ground being, as is alleged, the discovery of new evidence. It is fair to Judge Lowell, however, to say that he disavows all knowledge of the ownership of stock by relatives at the dates named, although, as executor of his father's estate which included $100,000 dollars of Bell Telephone Stock in 1881, it may seem difficult to convince the public that he did not know it. His explanation is that his brother, a co-executor, did all the business, and did not inform him that the stock in question was part of the estate.

The Cost of Charcoal-Iron Making in the South has been treated at length in the *Manufacturers' Record*, which assigns as the reason why the South makes a much greater proportion of charcoal-pig iron than its proportion of the total make of other pig iron, the fact that it still possesses an abundance of wood for charcoal near large beds of iron ore, with transportation near at hand, and with cheap and efficient labor. The article cited states that the South can make certain grades of charcoal-pig iron and place them at points of consumption much cheaper than they can be made in any section of the country and laid down in competing markets. It adds that this statement is especially true of new regions of the South recently opened up by lines of railroad; or rather, to be more exact, old iron-making regions that are now being made accessible by railroads. The fact is made to appear in this article that most, if not all of the so-called new iron districts in Virginia, Tennessee, Alabama and other parts of the South are old and noted iron-producing sections.

The Test of the Twelve-Inch Mortar at Sandy Hook on the 3d September proved this gun to possess a terribly destructive force. The first shot not only carried away a portion of the target, but so shattered it that further tests were impracticable. The target was a solid steel armor plate four inches thick. The shell weighed 628.5 pounds, and 51 pounds of Dupont's sphero-hexagonal powder in a canvas cartridge-case was the charge. The target was placed at 150 feet from the muzzle of the gun. The full charge is 80 lbs., the charge employed being proportioned to the distance of the target from the gun. The gun is 10 feet 9 inches long. The shell is designed to carry a bursting charge of 22 pounds, designed to first penetrate an armored deck of a warship, and then explode in the interior. It is stated that the shell is not yet perfected, one object of the test being to obtain data to guide further changes in the metal and construction, with the purpose to cheapen the shell to the last degree that it will bear without impairing its efficiency. The shell used at the test is stated to be of a better quality of steel than it is desired to use; yet it was somewhat broken and distorted by its impact upon the target. The latter was, however, of better steel than is commonly employed for the protection of decks, and the effect upon the shell is therefore considered as more severe than would result in actual use.

News from Lieutenant Peary's North Greenland Expedition appeared in the daily papers of September 4. The party has been safely landed and housed on the southern shore of Cape Cleveland bay, 800 miles south of the North Pole. Many interesting details of the voyage of the *Kite* accompanied the above simple statement. Before reaching the North Water, many severe encounters with ice were successively and successfully passed through, but nothing out of the ordinary course of arctic experience appears to have obstructed progress. The scientists of the expedition are elated at finding, among other minerals, a large meteorite, at a point on the coast of the channel which separates Disco Island from the main coast of Greenland. Observations of the coral beds found along the shores were made by Professor Heilprin, who also made observations of some extinct craters, wherein it is said some valuable mineralogical specimens were collected. An unfortunate accident befel Lieutenant Peary on the 11th July.

In a conflict with ice on that date his leg was jammed between the tiller and the wheelhouse, breaking both the tibia and fibula about six inches above the ankle. When the *Kite* left the party, Lieutenant Peary was rapidly recovering from this mishap, and the general health of the party, including the brave wife who is sharing her husband's hazardous fortunes, was good.

Irrigation in Wyoming is the subject of Census Bulletin No. 107. The report is restricted to land on which crops were actually raised by the aid of irrigation. The report states that "there are 1917 farms irrigated out of a total number of 3246. The total area of land in these 1917 farms is 1,506,850 acres, upon 229,676 acres of which crops were raised by irrigation in the year 1889. In addition to the irrigated area from which crops were cut or gathered, there were approximately 240,000 acres irrigated for grazing purposes. The average size of the irrigated farms, or, more strictly, of irrigated portions of farms on which crops were raised, is 119 acres. The average first cost of water-right is $3.62 per acre, and the average cost of preparing the soil for cultivation, including the purchase-price of the land, is $9.48 per acre. The average present value of the irrigated land of the State, including buildings, etc., is reported as $31.40 per acre, showing an apparent profit, less cost of buildings, of $18.30 per acre. The average annual cost of water is $0.44 per acre, which, deducted from the average annual value of products per acre, leaves an average annual return of $7.81 per acre.

The Use of Petroleum as Fuel has been extended to the manufacture of porcelain in France, and foreign papers seem to think that it is likely to revolutionize the porcelain industry. The *British Mercantile Gazette*, London, states that at a recent congress of manufacturers it was said that some new and cheaper method of manufacturing porcelain must be found for France, or the industry which has become so famous, and which employs so many people, would be driven from the country on account of the cost of firing. At this congress it was stated that the average cost of firing china in Bohemia was not more than 10 francs per ton; in England it was only 13 francs per ton; whereas in France the cost of firing the same class of goods was 34.50 francs per ton. This is a very great difference, and one which makes it impossible for the French manufacturers to make their china as cheaply as their foreign neighbors. The manufacturers at Limoges and elsewhere have been almost at their wits end. Various devices have been tried, but without much success. Wages have been reduced to the lowest minimum and still the manufacturers have lost money. The coal that is employed is necessarily costly, as a smokeless "long-flame" variety is required. Many of the factories use nothing but wood, as this produces a purer white than the very best kinds of coal; but wood is much dearer, of course, hence it is only used for the finest grades of porcelain. Many of the new processes which have been from time to time proposed have been too costly for success. Finally a progressive manufacturing house in Limoges made an experiment with petroleum as fuel. An American firm was requested to come to that city and make a trial. The results were far better than anticipated. The porcelain was in nowise discolored, but, on the contrary, it came from the kiln whiter and in better condition than when fired with the best of wood. The success of this experiment has determined the value of this fuel for the purpose, as a saving of 15% or 20% in the cost of manufacture was effected by it in the experiment described.

The Excellent Natural Harbor of Port Royal is to be improved by the expenditure of English capital represented by the Port Royal Company, in which upon the authority of the *Manufacturers' Record*, Messrs. Alfred Fryer of England and Samuel M. Jarvis and Roland R. Conklin, of Kansas City, officers of the Jarvis-Conklin Mortgage and Trust Company, of London and Kansas City, with their English associates, have purchased a controlling interest. It is intended to make this a great coal shipping port, as it is the natural outlet for the great coal fields of Kentucky.

With Reference to the Rainmakers, of whose work General Dyrenforth, the head conjuror, has been promulgating through the daily press glowing accounts, claiming the entire success of his experiments in Texas, we see no reason to revise our previously expressed opinions, that there is no scientific ground for the belief that violent terrestrial explosions are the cause of rainfall, and that the experiments upon this subject conducted by General Dyrenforth are a simple waste of good money. The experiment performed on the 11th August was heralded as a complete success. Mr. H. A. Hazen, of Washington, D. C., has taken pains to examine the weather maps of that date, and has communicated to *Science* the results of his examination. He says that "any one who will examine the weather maps, now sown broadcast over almost the whole country, will find that on the 11th August, there was a natural rain which extended over the whole of Texas and adjacent regions." It is significant that scientific men generally avow their unbelief in the possibility of manufacturing the conditions for rainfall. If at any date water is not contained in the air of any region sufficient to be precipitated under then existing states of temperature and barometric pressure, no earthly power is competent to change either the temperature or pressure of the air over an extended region to a degree necessary for the genesis of a storm. The *Mining Industry and Tradesman* (Denver) denies the statement made in the first despatches from Texas, to the effect that it was a very dry time, and that consequently the experiments were all the more satisfactory. It avers that, on the contrary, the date of the experiment was "a time of general showers," a statement confirmed above by Mr. Hazen and the weather maps. It adds that "the climate throughout the so-called arid regions has been so extraordinary this summer that for weeks at a time any rain maker or weather prophet would have had all the odds in his favor if betting on rain for a given day." It would seem, that so far from demonstrating the connection of rainfall with explosions, the experiments have thrown no light upon the question, and that the only reliable conclusion to be derived from them is that they are in charge of a director whose enthusiasm is a bar to correct inferences.

Record Breaking by Ocean Steamers has been of frequent occurrence recently, one of the latest ships to achieve this distinction being the steamship *Empress of Japan*, which made the voyage from Yokohama to Vancouver in ten days, beating the record between these ports by eight hours. The average speed for the entire trip was 19.75 miles per hour or 474 miles per day.

In Connection with Marine Record Breaking it should be mentioned that the Canadian Pacific Railway took the mail for New York from the *Empress of Japan* at Victoria and delivered it in this city *via* the New York Central Railway, in shorter time than has ever before been made by trains between these points. The mails for England, having been transferred here to the *City of New York*, reached Queenstown in a total of twenty days from Yokohama. This is an average rate of 500 miles per day for the entire distance.

A Good Chance for Young Men is opening on the Southern sugar plantations in connection with the new Sugar School, established in New Orleans under the auspices of the State of Louisiana and the Louisiana Agricultural and Scientific Association. This school has been organized to supply an existing want of skilled experts in the culture of cane and the manufacture of sugar. The pay which such experts receive is said to be very good; and the demand for their service has been increased by the bonus paid under the McKinley bill, which bonus depends upon the grade of sugar produced. A slight deficiency in the quality of the sugar may, under this condition, result in a large loss to the sugar planter.

A Curious Phase of Human Nature was illustrated during the inquest of the causes of the Park Place Disaster which occurred on the 22d August. During the progress of the inquiry there appeared in the streets near the City Hall and the Court of Sessions, in the hands of numerous street venders, the "*Park Place Horror Songster*." It appeared to sell well.

NEW PUBLICATIONS.

THE CENTURY DICTIONARY. AN ENCYclopedic Lexicon of the English Language. Prepared under the Superintendence of William Dwight Whitney, Ph. D., LL.D., Professor of Comparative Philology and Sanskrit in Yale University. Six volumes. New York: The Century Company.

The last volume of this great work is announced to appear November 1st. It will complete the most extensive and comprehensive dictionary of the English language ever published.

Altogether, this publication is one of the most brilliant examples of literary and business enterprise on record in the annals of the American press. A very large expense was entailed upon its publishers before any return for the investment was possible; and the organization and supervision of an efficient staff of readers or word collectors, and experts in the various professions, sciences and arts, together with a corps of able assistants for the preparation of the crude material sent in from all quarters of the globe where the English language is spoken, was a task, the difficulty and magnitude of which can be comprehended only by those who have had experience in similar work.

Probably no corps of workers ever gotten together in an editorial room wrought together with greater zeal and harmony than that one which for years labored at the production of the Century Dictionary. To the courteous manners, adroit management, and untiring industry of the managing editor, Mr. Benjamin E. Smith, A. M.. much of the *esprit de corps* which animated this large force is undoubtedly due; and the literary success of the work is to be largely attributed to the fact that every one employed on the editorial staff seemed to feel a personal interest in the outcome not only of his own labor, but that of every other co-worker. The mutual criticisms of experts were conducted in so courteous a manner, yet were so thorough, that, without giving offense, all the work was subjected to a system of checks essential to the attainment of the accuracy characteristic of the dictionary throughout.

This is not to say that no errors can be found in it; when was there ever produced an absolutely perfect dictionary of any language? We might also ask with equal pertinence, "when was there ever published a collection of definitions in which so small a proportion could be criticised?"

The need of a new English Dictionary is apparent from the fact, that while none of the heretofore existing dictionaries, contained all words in use at the date of their publication, there has been a very large number of words recently introduced which prior to the publication of the "Century," were not to be found in any dictionary. The march of progress in the sciences and the arts has brought into use entire new vocabularies, which are not only in use in the sciences or professions where they originated, but are also cropping out in current popular literature, as in the daily and weekly papers and the monthly magazines. The Century Dictionary has, at great pains, collected such words, and it will for a considerable time be a rare occurrence to meet in general reading any word not contained in it. It stands alone and above all others as the most complete collection of English words extant.

It is, of course, impossible to give anything like an adequate notice of such a work, in the space that can here be devoted to it. Its prominent characteristics and the principles observed in its preparation are well stated in circulars obtainable on application from the publishers; but a daily experience with the unfinished work, running through several years, compels the admission that, for professional workers, or for the general reader who desires to understand what he reads, it is simply indispensable. For those who are called upon to frequently use technical terms or to search for their signification, as editors, patent solicitors, specification writers, engineers, etc., it is an invaluable aid.

The typography and illustrations, which latter, though profuse, are never superfluous, are both in the very best modern style. It has already been justly said that "no library is complete without The Century Dictionary." It may be said with equal truth that "*it is a library in itself.*"

SOME EXPERIMENTS TO DETERMINE THE Strength of American Vitrified Sewer Pipe. By Malvard A. Howe, C. E., Professor of Civil Engineering, Rose Polytechnic Institute. Chicago: John W. Weston, 78 La Salle Street. 1891.

In the August number of THE ENGINEERING MAGAZINE, in the Department of Architecture, a brief notice of this paper was made, stating, however, only a few of the results attained. The pamphlet herewith noticed gives a full detailed

account of the tests made to determine the strength of glazed sewer pipe, with illustrations of the apparatus employed consisting of photogravure plates and diagrams, and the tabulated results, which show the mark of the pipes tested hydrostatically; their class; mean diameter in inches; mean thickness in inches; pressure in pounds per square inch and the ultimate strength per square inch in pounds. Tables of drop tests are also comprised in the treatise. These give the mark of the pipes tested; their class; mean diameter in inches; mean thickness in inches; maximum fall of weight in inches; number of blows; the product of the weight of the drop into its velocity, and the product of the weight into the height to which it was raised prior to its release. Other tables of results of concentrated load-tests; uniform load-tests; results of the cement joint-tests; the average ultimate tensile strength in pounds per square inch of the different sizes of pipes of the different classes respectively; the average tensile strength in pounds per square inch of the pipes of different classes tested by the different methods, together with the colors of the fracture corresponding to the greatest strength; the thicknesses of the various sizes of pipe, under the assumptions that the ultimate strength of the material is 600 pounds per square inch, that the pipes are subjected to a hydrostatic pressure of 100 pounds per square inch, and that the pipes are on the point of bursting; and the average ultimate strength in pounds per square inch of the different sizes of pipe, complete the work. What we have named of the character of this treatise shows that the investigations made by Prof. Howe were very exhaustive and the results obtained by him highly important to architects and engineers.

THE PREVENTION OF FIRE. CHIEFLY with Reference to Hospitals, Asylums and Other Public Institutions. By William Paul Gerhard, C. E. Second Edition. Published by the Author. New York: 39 Union Square, West. Price, postpaid, 60 cents.

This work, though having chief reference to hospitals, asylums and other public institutions, as indicated by its title, contains valuable suggestions applicable to other buildings. Its introduction recites the circumstances under which the book was written, referring to some of the awful calamities by fire in insane asylums, orphans' homes, etc., which now make a long list in the history of such disasters. The discussion of defective and unsafe building construction follows; and the treatment of the topics of Sound Building Construction; Fireproof Construction; Slow Burning Construction; Roof Construction; Defective Chimney Flues; Elevators and Staircases; Means of Egress; Fire Escapes; Heating Apparatus; Laundry and Drying Apparatus; Artificial Lighting; Protection Against Strokes of Lightning; Fire Alarm Apparatus; Watchmen; Supply of Water for Fire Extinguishing Apparatus; Fire Extinguishing Apparatus; Fire Rolls, and Fire Brigades completes the work. It would be difficult to say too much in praise of the compact, terse style and practical treatment of the subject which a very brief glimpse through this essay enables the skilled reader to detect. It is a book which should be in the hands of every medical superintendent of either an insane asylum or hospital, and it would be a valuable addition to the library of any one who wishes to become thoroughly informed as to the causes of fire in such institutions and their means of prevention.

"THE COMPASS," A MONTHLY JOURNAL for Engineers, Surveyors, Architects, Draughtsmen and Students. New York: Keuffel & Esser Co., 127 Fulton Street. $2 per year, post paid; single copies 20 cents.

The first number of this publication was issued August 1, 1891. Its form is small octavo, so that it can be very conveniently bound into handy volumes for the library. Its typography is excellent, and the paper on which it is printed is of excellent quality. Sixteen pages comprise the present publication, and the topics treated in it are strictly confined to those indicated by its title. The contents of the first number comprise a prospectus which is followed by an illustrated article on Compass Variations; an illustrated article on Engineering and Surveying Instruments; another on Drawing Instruments, not illustrated, and several articles descriptive of various drawing instruments and their uses.

"REPORT OF COMMITTEE ON SANITATION of the School Committee of the City of Lynn for the Year 1890." Lynn, Mass.: G. H. & W. A. Nichols.

This publication was sent to us by Mr. C. J. H. Woodbury, not with a view to a notice, but to call attention to some excellent results in ventilating old school buildings where the circumstances were such that it was necessary to continue the use of stoves. It describes an apparatus which is original, and does not involve the use of patented devices. In looking over this report, which is in pamphlet form, we have been much impressed with its value to school boards and others. Mr. Woodbury is a member of the American Society of Civil Engineers and of the American Society of Mechanical Engineers; and he is also Vice-President of the School Committee of Lynn. He is also the Chairman of the Committee on Sanitation of the School Committee of that city. We do not know whether this

pamphlet is on sale or not. Those who are interested may doubtless obtain copies by application.

EXPERIMENTS IN AERODYNAMICS. BY S. P. Langley, Washington, D. C., 1891. Published by the Smithsonian Institution.

This book is No. 801 of the Smithsonion Contributions to Knowledge. Professor Langley, in his introduction, states that "Schemes for mechanical flight have been so generally associated in the past with other methods than those of science, that it is commonly supposed the long record of failures has left such practical demonstration of the futility of all such hopes for the future, that no one of scientific training will be found to give them countenance." While recognizing that this view is a natural one, he has during some years devoted nearly all the time at his command for research, not directly to the purpose of any scheme for mechanical flight, but to one cognate to such purpose, to wit, mechanical sustenation; and the results reached by him by scientific methods he feels ought now to be made public. The purpose of the work is to demonstrate experimentally certain propositions in aerodynamics which prove that such flight under proper direction is practicable. The book is a large quarto of 115 pages, exclusive of 10 full page plates, which respectively illustrate the plan of the grounds upon which the experiments were made; the plan of a whirling table employed in the experiments; quadrant contacts of the whirling table; suspended plane; resultant pressure recorder; plane dropper; component pressure recorder; dynamometer chronograph; and both a side elevation and plan of the rolling carriage and chronograph used in the experiments. The work is undoubtedly by far the most important contribution to the science of aerodynamics which has yet appeared in the United States.

THE PRACTICAL ASSISTANT AND WORKshop Companion. A Treasury of Useful Information Relating to the Arts and Sciences of Every-day Life. Containing Useful and Reliable Recipes, Wrinkles, Methods, Rules, Data, Tables and Hints for the Factory and the Household, the Shop and the Farm. Edited by John Phin. New York: The Industrial Publication Company, 1891. Price—Paper, 35 cents; cloth, 60 cents.

The author states in his preface that the chief aim in this book has been to give recipes which will not disappoint those who attempt to use them. Some of the recipes are original, having been worked out and improved by the author after much labor and experiment. An effort has also been made to make a judicious selection of recipes, leaving out a large number, of which, in ordinary books of recipes, their only justification for existing is to fill out the book. In other words an attempt has been made to comprise in a compact form such recipes as are of real value, leaving out the worthless ones. This book is bound in either paper or cloth, the price for the former being 35 cents and the latter 60 cents.

ELECTRICITY. A WEEKLY JOURNAL PUBlished simultaneously in Chicago and New York. Electricity Newspaper Company, 307, 308 Temple Court Building, Chicago. $2.50 per annum.

The prospectus of this journal announces that it is to be devoted to the advancement of electrical interests, and that it is to be an attempt to present the popular side of electrical matters both practical and technical. It is based upon the assumption that a large class deeply interested in electrical work is unable to follow it in all its interests as technically presented in a large number of electrical publications now extant. An examination of the first and succeeding numbers shows that the attempt is intelligently directed and that a carefully edited, handsomely printed and valuable publication has been added to the list of electrical weeklies. The paper and typography and style of illustration leave nothing to be desired. A well-selected summary of electrical news is presented.

RECEIVED.

BULLETIN 30. Cornell University Agricultural Experiment Station. August, 1891. Some Preliminary Studies of the Influence of the Electric Arc Lamp upon Greenhouse Plants. The University, Ithaca, N. Y.

Office of Naval Intelligence. General Information Series, No. X. Information from Abroad. The Year's Naval Progress. Annual of the Office of Naval Intelligence. July, 1891. Washington: Government Printing Office.

Geological Survey of Missouri. Arthur Winslow, State Geologist. Bulletin No. 5. Published by the Geological Survey. Jefferson City, July, 1891.

Handy List of Books on Mines and Mining, Assaying, Metallurgy, Analytical Chemistry, Minerals and Mineralogy, Geology, Paleontology. An Alphabetical Catalogue, arranged under Authors and Subjects, and including Analytical References to the Contents of Important Works. Including Periodicals and Annuals and a Short List of Important Works in the German Language. Milwaukee, Wis. H. E. Hafferkom. London, Gay and Bird. 1891.

The Gospel of Good Roads. A Letter to The American Farmer. By Isaac B. Potter, New York: Published by The League of American Wheelmen, under Direction of its National Committee on Improvement of the Highways.

MACHINE-SHOP NOTES.

SO you were going to refuse to make that connecting rod because you had no planer that would plane concave? Well you *are* foolish. Your shop is full of them. You have a long, wide, thin rod with a big stub at each end, and you want it to be 2 1-2 inches thick at the ends and only two inches at the centre; relying upon extra width in the centre to give it stiffness to make up for the thickness taken out. Well, bolt it to your planer bed, and spring it up and block it up in the centre one-fourth of an inch; plane that side, turn it over and spring and block it up in the centre one-half of an inch and plane that side; there you are.

Jobs are none too plentiful in most shops for a proprietor to turn them away because he don't happen to think of how to do them, the first time they are poked at him.

* * *

Now don't you complain of that man being slow. I had him work for me once and I thought at first that he was slow, he took such an everlasting time getting ready to do every job that he undertook. He would be tinkering here and fiddling there with apparently nothing to show for it but a time card. But when he did get really to work turning out things it would surprise you the number of them that left his lathe and their perfection in dimension and finish. He is what you may call a "jig man." If he has more than about six of anything to make he will get ready to make them all at once like buttons. That is his way. He knows just how much it will cost to make them "each by each" in the old-fashioned and usual way. He knows how long it will take to make them with a certain number of jigs, and how long to make them with a certain other number of of jigs. If he has anything lying about that he has used for similar work before, and the cost of which he does not allow to enter into his calculations, he uses it. He figures up how much it is going to cost to enable him to save $10.00. If it will cost $5.00, he goes ahead and makes the fixings. If it costs $11.00. he don't. I think that if it cost $9.75 he will make them. The man next to him tried to be funny and told a story about a convict confined at hard labor breaking stones for ten years, and who hammered at the same stone for the whole of the ten years, on the ground that it was a hard one and he could not break it. When he was discharged (I mean the convict, not the man next your jig man) the keeper seized the sledge and broke the stone with a blow. "Of course," said the now ex-convict, "after I've been softening it for you all these years."

Well, the man next the jig man is not so wise as he is funny; and he is not overly funny, either. I would rather give the jig man $4.00 a day than his supposedly funny neighbor $2.75. If he did not make up the difference the first week, on regular work, he would the second, when something came in that was out of the ordinary run.

* * *

So your wire kinks on you and won't straighten when you want it to, charm you never so wisely? Well, that is because it is "built that way." That wire was made by drawing through a set of dies, as most wire is; and it was coiled right up after passing through each die; the coil only a yard or so from the die. Just as it was hot from the die, and as its particles had been made to understand that they must go just where they were put and stay where they were put, they were coiled up in those circles of small radius. Mindful of the lesson that they had just received, they are staying where they were put. Rev. Dr. Watts says:

> "Let wire delight to coil up tight,
> For 'tis its nature to."

Or something like that. If you want wire that won't keep a permanent kink, tell your wire maker that he must put the

reels about fifty feet away from the dies; then each piece of wire will have a chance to get reasonably cool before it goes into the coil; and it will consider that the straight line is its normal and desirable condition and that the coil is only a temporary shape assumed for purposes of convenience. Wire has a deal more sense than some people.

* * *

For that work you want the very best steel that money can buy; and that is not the latest steel turned out from the works either. You want steel that has been made for twenty years, and that has been lying by without being disturbed. During all that time it will have been recovering from the derangement of its particles, caused by the breaking down rolls, and the hammering which it underwent in the process of manufacture.

Is that a theory of mine? Yes, it is a theory. It is not a hypothesis, which means merely an idea. It is a theory; meaning an idea based on enough facts actually observed, to warrant my forming a theory from them. It is a fact, and it has been observed by many a good mechanic who has been long enough in business to enable him to have a number of facts to draw on, that steel improves by age, particularly if it is not disturbed by usage. Such a conservative firm as Hoe & Co., keep one bin specially for steel to go in their press bed rollers. For they must have the very best steel that money can buy, and knowledge can select. They estimate that it improves five per cent. a year by just lying in a bin; and you could not buy from them for $10 a pound the stock which they reserve for those rollers.

* * *

To test whether that man has properly learned his trade in the shops from which he says he has graduated, I just gave him a piece of cast-iron about 6 x 4 x 1 inch, and told him to file it hollow on the broad side and dead square on the narrow edge. In about half an hour he brought it to me saying that no one could file it hollow; and what he considered to be dead square on the narrow edge reminded me of a boot-back.

A man who can't file dead square is of no use. To be sure we have machines that will finish that block in five minutes better than any average mechanic would be apt to do in a week; but what I want is the ability to do things—so that if the machine is broken, or in use by some one else, or the work is not to be done in a shop, the man will be able to do it. When it comes to filing the flat side hollow, any good mechanic should be able to spring a file so as to reach in and do that. The "mechanic" who has never been taught to do things and who has not enough innate mechanical ability to think out a process for himself, will give it up. Him we do not want.

* * *

While I'm making this little working drawing I want you to notice my drafting tacks. Those that most people use are either of the kind which have the points riveted into the head, or they have them screwed in. If they are riveted in, they pull out. If they are screwed in, the motion of pressing them in with the thumb is very apt to unscrew them. If they have thin heads they are of no use. If they have thick ones the heads get in the way of the T-square. If in order to do away with the coming out of the points, (or the coming off of the heads), you get them turned out of the solid, they cost a lot of money and you have them in the way of your T-square all the same. Then if you drop any of them the only way that you can find them is by stepping on them, and if your shoe-soles are thick you don't find them then, but carry them around like hob-nails. Now, I use just plain, ordinary every-day copper tacks; the smallest that I can get. They can be pressed in and withdrawn with a knife blade; they have just as good a hold as the German silver or steel ones, and deface the board less; and ten cents worth will last about two years with any degree of care.

* * *

You took Sunday off, last week, did you? and the Sunday before that? And you intend to take other Sundays in the future, with an occasional fishing or attending convention or something like that?

Well, give your tools the same rest that

you give yourself, and more too, and you will find that they will be better for it. You have probably found out that it pays you to see a razor for a few minutes and then to lay it aside and work with another for a few months. Well, there are many tools about your shop that would be the better for being laid aside once in a while and given a chance to arrange their particles in such a way as to do the best work. This is no whim; it is a fact that shop tools do better for a rest, just as razors and razor-users do.

* * *

No, I don't want to buy any cheap monkey wrenches, I can get more wrenches for sixty-two cents apiece, than I want. What I want is a wrench that costs about $2.50 and will last about seventeen years. These cheap things are made of cheap stock by cheap processes; and while they may be good enough for ordinary work, they are not good enough for a high grade mechanic. I want something of steel, with the threads cut not perhaps quite so well as those on a lathe, but excellently well; with the head and sliding jaw milled off and finished up like gun-work. I want the screw to run freely but without lost motion; and the jaws to close squarely and not deface stock that they take hold of. Such a tool as that will do better work than the common one, and whoever handles it will try to do better work than if he has one of the common kind, some of which are only about good enough to throw at a cat.

* * *

You have to plane cast iron sectors each covering 1-6 of a circle 40 feet in diameter, and you don't see how you are going to plane them? Suppose you refuse every job that comes in, for which there is not a special tool waiting all ready labeled "this is for boring, turning, facing, drilling, countersinking, and tapping the armatures of chain lightning electric motor, size 7½ 2'."

You have no open side planer, but it is not much of a trick to make one out of one of regular type; nor is it much of a smart thing to rig up a pivoted post about 20 feet from the centre line of the planer and pivot the centre of your sector there; its rim lying on the planer bed at the same level. The sector will have to swing if you drive it right; it will have to swing in the arc of a circle because its centre cannot get away; and you will find after a few trial passes without any tool that you will be ready to take a trial cut without much misgiving.

* * *

That painters' staging is going up because I am going to give that east wall a coat of thin cement. I have painted it and it is not yet tight against the beating rainstorms; and the steel that is stored on the inside of it will not keep in good condition. What I am going to do is to give it a coat with a whitewash brush, of good hydraulic cement, made as thin as whitewash. You will see a north wall done in that way, in Hoe's press works; the color is cool, neat, sightly and appropriate, and the wall is rain-tight even in the heaviest storms. The cost of the material is very little, and that of putting it on less than if applying stiff paint.

* * *

If you will take my advice in making that frame, you will make every mortise a little flaring at the bottom, and then drive hard-wood wedges in the tenons after they are sent home to the shoulder. That will expand them and make them fill the mortises, and the man who undertakes to draw them will find that he has, not his hands, but his mortises, full.

Oh, they are blind mortises are they, and you can't wedge them that way? Then let them wedge themselves. Make the mortises dove-tailing, all the same; cut lengthwise kerfs in the end of each tenon, and make good wedges; insert the points of the wedges, and then drive the tenons in square. When the butts of the wedges reach the bottoms of the mortises, the only thing they can do will be to go into the tenons, and the only thing for the tenons to do under the circumstances will be to expand and fill the mortises.

The only objection to this plan is that if at any time any one ever wants to knock down those frames, he will find it cheaper to saw off the sticks at the shoulders, than to draw the tenons.

EDITOR'S EXCHANGE TABLE.

ILLUSTRATED articles are indicated by an asterisk (*), continued articles by a dagger (†), and concluded articles by a double dagger (‡). Ordès for copies of publications mentioned should be sent direct to the addresses given.

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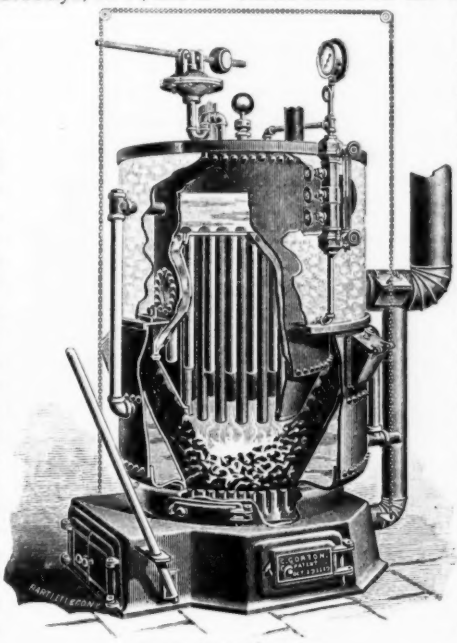
THE GORTON SOFT COAL BOILER. A distinctly new type of heating apparatus, which promises to play an important part in the important and growing field of household engineering, is the Gorton soft coal boiler, which we illustrate on this page. It is the invention of Mr. Charles Gorton of Brooklyn, N. Y., and in design is unlike any other soft coal boiler now upon the market. The very satisfactory results obtained from a number of tests made by the manufacturers, lead those who have witnessed its performances to believe it the long-sought boiler for burning soft coal, which is so abundant in the South and West, but which from its tendency to deposit soot upon the heating surface of the boiler in which it is used, has given much trouble, and, indeed, rendered its use far from economical, in spite of the cheapness of such fuel. A number of styles of soft coal burning boilers have heretofore been devised and used with more or less satisfactory results, but the construction of none of them can be said to have entirely compassed the troublesome soot question.



GORTON SOFT COAL BOILER.

The thick black smoke which causes the deposit of soot and unconsumed carbon on the heating surface of the boiler is given off when the coal begins to burn, or coke, and ceases when that part of the combustion is perfect. In the construction of the Fire Pot of the Gorton soft coal boiler, sufficient additional air is drawn through the fingered ring above the outer surface of the grate, at the lower edge of the coking chamber to ignite all the gases arising from the coking process, thus preventing the deposit of soot and unconsumed carbon on the heating surface of the boiler, and making effectual that part of the fuel which is generally wasted when soft coal is burned in all ordinary fire pots.

The construction of the boiler, which can be readily understood by reference to the illustration, is such that it generates steam in the most economical and effectual manner, as the gases come in contact with the tubes and inside of the shell at the highest temperature, and cooling, pass through the opening in front of the boiler and around the shell before going out of the smoke pipe at the rear. The boiler proper is surrounded by a non-conducting jacket of galvanized iron, lined with asbestos sheeting, thus confining the heat generated to its proper channel and preventing radiation. The main or tubular part of the boiler is directly over the fire. The water-leg or lower part surrounds the fire and is connected with the boiler above by suitable circulation pipes. The coking chamber and coal reservoir, which is annular, is between the lower

outer surface of the boiler and the upper part of the water-leg, and will hold enough coal to last for twenty-four hours.

The position of the coal pockets is such that the reservoir can be easily filled as an ordinary kitchen range. The fingered ring allows the air to pass through the fire, thus keeping up a sharp fire long after the grate is covered with ashes. The grate is of an improved form which does away with any necessity for stooping.

The sole manufacturers are the Gorton & Lidgerwood Company, 96 Liberty Street, New York, who will cheerfully furnish any further information desired.

A NEW TEMPERATURE REGULATOR.—In the leading article entitled "The Ventilation of Homes and Schools," by Mr. Leicester Allen, in our September number, there was an allusion to a new automatic regulator specially designed for the control of hot water heaters. It is the invention of Mr. W. P. Powers, for many years a steam and hot water heating engineer.

The peculiarity of this regulator is that it has a dual action. One function controls the heater and the other the house, each being entirely independent of the other, and yet working in perfect harmony.

The dampers of the hot water heater are closed just before the boiling point is reached, by steam pressure generated from water confined in a supplemental chamber located in the flow pipe and heated by the circulating water. The well known law that the boiling point of liquids varies according to the pressure upon them, lies at the foundation of this very ingenious device. The water in the heater being under a pressure due to the height of the expansion tank, must be heated considerably above the normal boiling point (212°) before ebullition takes place. But the water in the supplemental chamber being under no pressure, begins to generate steam as soon as a temperature of 212° is attained, and before the boiling point of the water in the system has been reached the damper is closed. So we have here the apparent paradox of live steam being formed by the heat of water which itself is not hot enough to boil. It is easy to see the advantages that follow the use of this device, as by its aid the water can be automatically maintained at this high temperature without any danger of boiling over, adding materially to the heating capacity of the radiator.

While controlling the heater in this manner, this regulator in its "duplex" character also governs the temperature of the house by an arrangement of the same general nature. A hollow oval disc of metal, ornamental in appearance, is hung upon the wall of one central room of the house, usually one of two or three opening together. This disc called a thermostat is divided into two parts by an elastic metal diaphragm. One of these compartments contains a liquid which boils at the ordinary temperature of a house, beginning to vaporize at 60 degrees and at 70° affording a vapor or steam pressure of three pounds to the square inch.

By this pressure the metal diaphragm is flexed and its force is transmitted by air confined in a very small tube to the heater, where it operates to close the damper raising a weight on a lever, by the adjustment of which the temperature of the house is maintained at any desired point. If the temperature of the house falls a little the damper opens a little. If it falls more it opens more, and so as the house warms up the draughts are gradually closed. As the inventor says: "It endows the heater with intelligence enough to open and shut its own damper, just when it ought to and just as much or little as it ought to."

This peculiar feature of the gradual movement of the damper renders it particularly desirable as a regulator for hot water, or in fact for any heating apparatus, it being used with great success on steam and hot air furnaces.

The dampers do not open and close at intervals as is the case with all other regulators, but they assume the right position to give the required amount of air to the fires and there remain without apparent change. This is the correct principle and gives an even steady fire with the least possible consumption of fuel. Manufactured by the Powers Duplex Regulator Co., 36 Dearborn Street, Chicago, Ill.